DOCUMENT RESUME

ED 098 096 SO 007 866

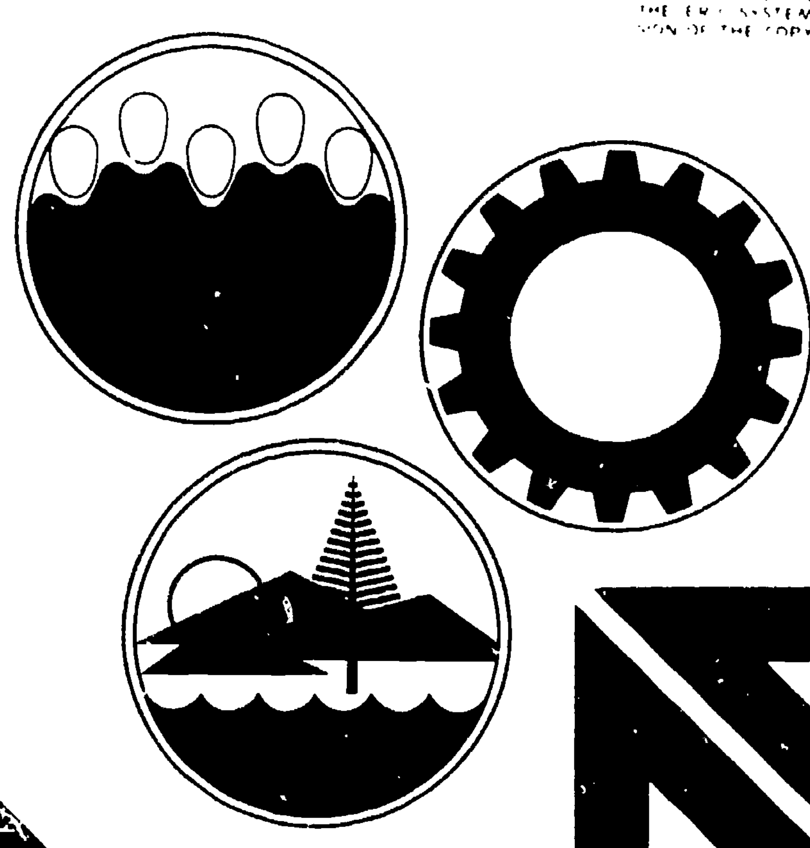
TITLE	Resource Recovery Overview [Teacher's Guide]; Resource Recovery and You [Student Book]. Resource Recovery Education Program.
INSTITUTION	National Association of Secondary School Principals, Washington, D.C.; National Center for Resource Recovery, Inc., Washington, D.C.
PUB DATE	74
NOTE	56p.; Related documents are SO 007 867, 868, and 870
AVAILABLE FROM	National Association of Secondary School Principals, 1904 Association Drive, Reston, Virginia 22091 ($12.00 for kit, 20 percent discount on orders of five or more)
EDRS PRICE	MF-$0.75 HC Not Available from EDRS. PLUS POSTAGE
DESCRIPTORS	Career Education; *Conservation (Environment); *Ecology; Energy; *Environmental Education; Futures (of Society); Interdisciplinary Approach; *Natural Resources; Program Descriptions; Recycling; Resource Materials; Secondary Education; Teaching Methods; *Waste Disposal

ABSTRACT

The Resource Recovery Education Program contains a variety of ideas, approaches, and learning aids for teaching about solid waste disposal at the secondary level. The program kit consists of a teacher's guide which provides an overview; separate teacher's guides for social studies, science, and industrial arts; a student booklet of readings; and a wall chart. Each of the components can be used independently of the other. The program is intended to introduce students to the problem of solid waste disposal and to involve them in doing something about it. Teaching strategies involve the student in community studies, research, and classroom discussion. The teacher's guide and the student book are available in this document. For other components of the program see the related documents listed in the descriptive note. The teacher's guide discusses the need for teaching about solid waste disposal and the approach to content used in the program. It also describes the six components of the program, the unit topics, and specific objectives and presents information on environmental careers and industrial resources. The student booklet contains a fictional story followed by a section on basic environmental principles, a list of organizations that make available free and low-cost materials, and a glossary of terms. (Author/RM)

Teacher's Guide

RESOURCE RECOVERY OVERVIEW



National Association of Secondary School Principals
1904 Association Drive, Reston, Virginia 22091

National Center for Resource Recovery, Inc.
1211 Connecticut Avenue, N. W. Washington, D. C. 20036

BEST COPY AVAILABLE

RESOURCE RECOVERY EDUCATION PROGRAM

EDUCATIONAL ADVISORY COMMITTEE

Owen B. Kiernan, Executive Secretary, National Association of Secondary School Principals

Merrill Hartshorn, Executive Secretary, National Council for the Social Studies

Robert Carleton, Executive Secretary (Ret.), National Science Teachers Association

Edward Kabakjian, Executive Secretary, American Industrial Arts Association

James Becker, Executive Director, National Foundation for the Improvement of Education

PROJECT STAFF

Thomas F. Koerner, Editor and Director of Publications, National Association of Secondary School Principals

Wade St. Clair, Director of Information, National Center for Resource Recovery

Robert Bird, Manager of Community Services, National Center for Resource Recovery

Jordan Sachs, formerly President, MSC Macalster

PROJECT TEAM

Coordinator **James V. Bernardo,** Teacher, School Administrator, Curriculum Specialist, Author; formerly Director of Educational Programs, National Aeronautics and Space Administration; presently Chief of Educational Programs, NCRR.

Science Section **Avery Dennis, Ph.D.** in Organic Chemistry, University of North Carolina; on faculties of Louisburg College, Louisburg, N. C., and University of North Carolina, Chapel Hill, N. C.; presently chairman of Science Department, Sandhills Community College, Southern Pines, N. C.

Social Studies Section **Richard Scott Craddock, Ed.D.** in Curriculum and Instruction, Duke University; Teacher, Supervisor, Principal in North Carolina Schools; on faculty, University of Delaware and educational consultant to several Latin-American countries; presently Head of Elementary Education Department, Western Carolina University, Cullowhee, N. C.

Industrial Arts Section **Delmar W. Olson, Ph.D.,** Ohio State University; Author and recognized authority in Industrial Arts and Technical Education; presently Professor and Coordinator of Graduate Studies for Industrial Arts, North Carolina State University, Raleigh, N. C.

A CHALLENGE: WEALTH IN WASTE

Principals and teachers have an obligation to acquire insight into and knowledge about major issues facing society today in order to be able to teach effectively and adequately prepare students. One complex issue of growing national interest has to do with the broad area of the management and utilization of both human and natural resources. As we approach the mid-1970's, Americans are facing the confounding situation of shortages of many products which have become accepted as necessary ingredients in our advanced life style. Metals and minerals — once presumed to be abundant — are increasingly in short supply. Of more immediate concern is the energy crisis precipitated primarily by the shortage of oil and other fossil fuels.

Recognizing what Dr. Richard L. Lesher, president of the National Center for Resource Recovery, has characterized as the "movement from an age of abundance to an age of scarcity," the increasing challenge of this decade is to effectively conserve, manage, and utilize the finite resources of our planet. This charge spurs the realization that there is a ready, but virtually untapped, source for many desired resources: our mounting heaps of garbage and trash.

Some 4.3 million tons of solid waste are generated in the United States annually from all sources. Of this, roughly three percent is municipal solid waste. Improperly handled (as too often it is), this creates environmental problems; further, many municipalities are hard-pressed to find disposal sites for the increasing volume. Proper management and resource recovery from mixed refuse offer a positive solution for reducing the amount of refuse that can be disposed of in an environmentally acceptable manner, while reclaiming needed materials and values for new use.

In the daily discards from homes, schools and businesses are materials that can be recovered, and metals and minerals that can be substituted for virgin resources in the manufacturing process. More significantly, waste can be utilized as an economical and ecologically desirable fuel in urban areas where energy demands are the highest.

A recent report from the U. S. Environmental Protection Agency indicated the potential energy available from solid waste. If energy recovery were practiced in all major urban areas, the report noted, an estimated quadrillion BTU's of energy would be added to the nation's energy pool. This quantity of energy is equivalent to about 1.5 percent of the nation's total energy consumption; or, the nation's entire energy consumption for residential and commercial lighting; or more than half of the direct oil imports from the Middle East in 1972.

In many cities over the next few years, programs will be adopted to collect waste paper and systems will be installed to mechanically process the mixture of garbage and trash to extract valuable metals and minerals. The remaining combustible residue can then be used for fuel.

It seems to me a vital goal is to learn and communicate present efforts to eliminate ill effects from solid waste while exploiting its inherent values. An informed teacher and student citizenry can then assist in shaping enlightened community response to these challenges. This Resource Recovery Education Program is an important step in supplying information and perspective to teacher and student. The kit was developed by the National Center for Resource Recovery (NCRR), a non-profit research organization, in cooperation with the National Association of Secondary School Principals. Counsel and assistance has been provided by an interested and involved Advisory Committee to the project: Dr. James Becker, National Foundation for the Improvement of Education; Robert Carleton, National Science Teachers Association; Dr. Merrill Hartshorn, National Council for the Social Studies; Dr. Edward Kabakjian, American Industrial Arts Association; and myself.

We are pleased to join with NCRR in this effort to assist in developing basic understandings of the exciting and significant drive to garner wealth from waste.

nassp

Owen B. Kiernan,
Executive Secretary,
National Association of
Secondary School
Principals

INTRODUCTION

Environment seems to be the watchword of the 70's. It has burst into the public mind almost overnight and is of particular concern to our school and college youth. The early rumblings of concern are having resounding echoes in Washington. Young citizens, who are the ecology movement's chief patrons, demand to know more about environmental problems, about the realities of what can be done, and about productive ways of getting involved.

The problem of solid waste is not a new one: throughout history people have discarded refuse with little thought for where it goes. Today the problem has become acute because of growing pollution and the danger to the environment from improper solid waste disposal. Until recently most of our environmental concern centered on threats to our air and water. Except for some scattered attention to litter, very little educational focus has been placed on the problems of solid waste caused by the inefficient and improper management of our trash and garbage. Today responsible citizens are becoming concerned with finding solutions to the problems of solid waste. And, just as young people of the 60's saw the first steps taken to explore space students of today will see a new era of science and technology devoted to conserving our earth. They will share in meeting the challenge of finding value in what has traditionally been worthless. In doing this, they will be helping to protect the environment and to improve the quality of life for themselves and for future generations.

The National Center for Resource Recovery (NCRR), a nonprofit corporation, was founded by American industry and labor to coordinate the efforts of industry with those of government in developing lasting solutions to the nation's solid waste challenge. As an important part of its responsibility for developing public awareness the NCRR has initiated an educational program, with instructional materials and aids to learning, to help schools and colleges in this important field. This venture is the *Resource Recovery Education Program*, a multidisciplinary package designed for secondary school students.

The Resource Recovery Education Program contains a variety of ideas, approaches, and learning aids for the teaching of the fundamental concepts usually included in the curriculum of the secondary high school. The materials offer teachers and students interesting choices of activities and ways to proceed from concrete facts to more subtle and abstract environmental concepts.

The Program has been developed so that each component can be used separately; there is no need to use all the items. The choice of materials to be used at a secondary school level is left to the teacher. This allows a spiral approach, with the study in one grade repeated in the next grade in greater depth and variety. The first teacher lays a basic foundation upon which the next teacher builds and elaborates.

Since the guides contain instructional materials and ideas in three major curriculum areas—science, social studies, and industrial arts—there is also an excellent opportunity to apply an interdisciplinary approach when practical and proper. Thus, where team teaching is practiced, several different dimensions of the solid waste challenge can be considered, and students can become more aware of the many social, economic, political, and technological processes that are so much a part of their own communities.

The basic objectives of the Program—and of the NCRR—are represented in our modern version of the Chinese infinity symbol that appears below. The circle shows the ultimate goal of closing the loop in the solid waste stream so that all possible resources are recovered. The space left open represents the distance remaining before the ultimate goal is achieved. We at NCRR are pleased to be able to present this program in order to share information about the challenge of resource recovery and, hopefully, to hasten the day when the circle will be closed.

Richard L. Lesher,
President, National Center
for Resource Recovery

APPROACH TO CONTENT

BEST COPY AVAILABLE

The purpose of the Resource Recovery Education Program is to introduce students to the problem of solid waste disposal. The problems of air and water pollution are well known, and steps are being taken to deal with them. But because the problem of solid waste—the "third pollution"—has been recognized only recently, people are less aware of it and of the mounting environmental and social problems caused by it. Now that the problem is beginning to receive attention, it is essential that students learn about solid waste pollution and that they become involved in doing something about it. The Resource Recovery Education Program is designed to meet that need.

The study of solid waste disposal includes many aspects of the problem. First, students must become aware that the problem exists. They must become familiar with scientific facts and technological developments related to waste disposal and recovery. And because people's awareness and attitudes are basic to the problem, students should be involved in developing public concern about waste. Finally, students need to consider the implications of waste disposal and resource recovery for themselves as individuals and for society as a whole.

In the various components of the program an objective review is provided of solid waste management—of definitions, causes, methods for control and recovery, and costs. On the basis of this information the student is involved in activities that require observation and interpretive thinking. Included also are critical reading and thinking skills, together with techniques for locating, analyzing, and applying information to the problem-solving/decision-making process. Throughout the program emphasis is given to understanding abstract concepts rather than to compiling sets of facts. Inquiry is stimulated through investigation, record-keeping, and experimentation. Because the learning experiences are open-ended, the student is enabled to make personal discoveries through questioning and to draw his own conclusions through the development of a framework of understanding. As a result the student is motivated to form his own analysis of, and insights into, today's solid waste challenge.

Instructional materials. Materials for studying resource recovery are available at little or no cost from a variety of sources, such as newspapers and magazines, industrial and labor organizations, governmental agencies, and various organizations concerned with the environment and with solid waste management. A list of these organizations is included in the students' booklet, and students may assist in writing (as well as in clipping, organizing, and filing materials) for information. It is suggested, however, that only one letter, written on official school stationery, be sent to each agency or organization.

A word of caution should be noted about free and inexpensive materials. Such materials often emphasize the interest of the sponsoring organization, and this interest may be reflected in the preser[illegible]on. However, this fact should not preclude th[illegible] of such materials; it simply means that students and teachers should be careful to seek a balanced perspective by using a variety of sources. Actually, a careful analysis of these materials and a comparison of the facts and viewpoints presented can constitute a valuable lesson in critical reading and evaluation.

Other instructional materials (books, films, slides, etc.) are available from conventional publishers and producers of materials for school use. A wise course of action, both economically and pedagogically, is to purchase one or two copies of many different references, rather than many copies (that is, a full class set) of only one or two references. In this way students are exposed to different kinds of reference materials at various levels of difficulty.

Student activities. The activities suggested in the teacher's guides are designed to promote the greatest possible participation and involvement on the part of the students. Hopefully, the teacher and students will undertake a study of how their community handles its refuse. This study should be conducted on an inquiry-discovery basis that utilizes many different aspects of the problem-solving process.

Many of the activities suggested are open-ended, with emphasis on locating and gathering information—sometimes in printed sources, but often from firsthand, or primary, sources. The very process of trying to accumulate necessary data and to determine the facts presents certain difficulties (such as incomplete and changing information or conflicting evidence) that are in themselves valuable learning experiences. In real life, people are continually forced to make decisions and take actions based on incomplete and contradictory evidence, and students need exposure to some of the complexities of problem analysis and decision-making.

Some exploratory activities are designed to initiate the study, to encourage questions, and to develop interest and motivation in the students.

Other activities, developmental in nature, are intended to develop a basic understanding of concepts. The various activities may be done by individuals, pairs of students, small groups, or even the entire class. In most cases more activities are suggested than any single class will want to undertake.

Questions for discussion and research. The questions are designed to stimulate thinking, discussion, and research. They should promote inquiry, suggest the possibility of significant relationships, and lead students to draw conclusions on their own. Many of the questions, like the activities, are open-ended and should generate divergent thinking. The teacher should take the time necessary to help students become aware of the partial and tentative nature of many of the answers and should avoid leading students into accepting a single answer where none exists.

Basic understandings to be developed. The basic understandings represent the main concepts and ideas; they also include pertinent points of information related to the various topics. Hopefully, the teacher will refrain from "teaching" these basic understandings in the sense of telling or explaining them. Too great reliance on expository readings or audiovisual materials that also simply tell or explain should also be avoided. Instead, teachers should permit and encourage students to develop these understandings on their own through the kinds of active participation and involvement suggested by the activities and questions.

The factual information and content related to solid waste management are secondary in importance to the more significant basic understandings. Specific details and facts vary and change rapidly, depending on time and place, whereas the basic understandings persist. Consequently, any emphasis on expository teaching, rote learning, and memorization of "last year's facts" is strongly discouraged.

Affective learnings. One of the more important goals of instruction is the development of desirable attitudes, values, and behavioral patterns. Certainly, the issues of environment, conservation, and management of urban litter and solid waste are closely related to the affective aspects of our lives, and it is impossible to study and discuss these topics without concern for values and value conflicts.

Although the teacher should avoid rank indoctrination, it is nevertheless desirable to encourage the development of certain affective objectives. Some of these relate to working together harmoniously (as in committees), sharing (information and materials), taking turns, listening attentively to others, criticizing constructively and fairly, and participating (as either a leader or a follower). Other attitudes and behaviors, related more directly to the search for knowledge, involve objectivity, love of truth, willingness to seek and present all the evidence, awareness of one's own preferences and prejudices, and a desire to avoid exaggeration and distortion.

James V. Bernardo,
Chief of Education Programs,
National Center for
Resource Recovery

DESCRIPTION OF COMPONENTS

The Resource Recovery Education Program contains guides for both teachers and students, as well as resource materials for general use. This set of brief but balanced components should provide students with a basic understanding of today's solid waste challenge, with emphasis on conserving our limited natural resources.

Teacher's Guide. The Overview is designed to introduce teachers to the philosophy and scope of the entire program. A list of unit topics and specific objectives provides more detailed information. A survey of environmental careers contains a general checklist of career fields and the academic preparation necessary for specific occupations. Finally, a list of instructional resources contains an up-to-date selection of books, articles, and films pinpointing materials related to each of the major topics.

Industrial Arts, Science, Social Studies. The teacher's guides for social studies, science, and industrial arts follow an identical structure and approach, with emphasis on the use of process methodology. Together, they provide a more complete teaching-learning experience than would be possible within a single subject. Because the problems related to solid waste cut across subject lines, it would be highly desirable for teachers in all three disciplines to cooperate in team-teaching the materials—a method that will demonstrate how close the separate disciplines are in relation to the central theme. However, the program materials are entirely suitable for single class study if the course is organized in that way.

The content of each of the teacher's guides is organized around five main topics:

I. Solid Waste: A Growing Problem
II. Collection and Transportation
III. Disposal
IV. Resource Recovery
V. Solid Waste Management Systems

Each of these topics has in turn been organized into five sections:

A. Objectives
B. Student Activities
C. Questions for Discussion and Research
D. Basic Understandings to Be Developed
E. Instructional Resources

The *Student Activities*, in Section B, are related to concepts, with questions or suppositions presented in the hope that direct experience will enhance understanding. The activities are designed to involve students in analysis and problem-solving; they stress the importance of an individual's evaluating evidence for himself as well as seeking expert opinion. If the activities influence the student to rethink an attitude, question a commonplace idea, or make a new value judgment, then a worthwhile goal has been achieved.

The variety of questions in Section C, *Questions for Discussion and Research*, should help students to review their learning and to apply their knowledge to actual life situations. The summary in Section D, *Basic Understandings to Be Developed*, is intended to aid the teacher and the students in evaluating their progress.

A basic premise behind the structure of the teacher's guides is that students can learn the skills of scientific investigation while they are gaining an understanding of important environmental principles. There is generally an adequate amount of information contained in the kit materials for achieving the stated objectives. If more information is needed, suggestions to students and teachers for further research and reinforcement activities for each topic are listed in Section E, *Instructional Resources*. There is also an abundance of excellent information made available by organizations, industry, and government (see the List of Organizations in the students' manual).

Resource Recovery and You (three copies). The students' booklet opens with the story "Resource Recovery and You," which provides a fictional setting for confronting students with the problems of solid waste. In the course of the story the emphasis shifts from present practices in waste disposal to future possibilities for resource recovery. This change recognizes that the positive solution to the problems of increased waste and higher costs lies not in the disposal of waste but in the recovery of valuable resources from municipal refuse.

In the other major section of the manual, "A Survey of Resource Recovery," basic environmental principles are introduced as a framework for later understanding and a serious look is taken at current municipal collection and disposal practices. Successive topics describe new efforts and systems under way to help solve this growing problem while also illustrating the use of technology to reclaim glass, metals, aluminum, paper, plastics, and rubber. Some of these recovered materials can be converted into new products; others can be used to provide energy or heat. A concluding section explores the subject of solid waste as a problem for human planning and emphasizes that all people, not only ecologists, must meet the challenge.

The students' manual also contains a thought-provoking section, "Getting Involved In Resource Recovery"; a list of organizations that make available, on request, free and low-cost materials; and a glossary of terms related to solid waste.

Wall chart. A wall chart has been included in the package as another approach to resource recovery. It should be hung on a bulletin board or in some other prominent place in the classroom. The chart traces the major steps in handling solid waste and in recovering resources, beginning with a garbage truck hauling away household and commercial waste and ending with the operation of a recovery plant. This schematic flow chart provides a comprehensive picture of how a full recovery system works.

UNIT TOPICS AND SPECIFIC OBJECTIVES

As you review the *Objectives* (Section A of each main topic in the teacher's guides), you will notice that each objective is identified by one or more symbols (*SS* for social studies, *S* for science, and *IA* for industrial arts). These symbols show immediately which of the three corresponding, matching teacher's guides has materials pertinent to a given part of the curriculum. Through these objectives students can easily see the many interacting facets of the solid waste challenge.

IA S SS

I. SOLID WASTE: A GROWING PROBLEM

A. Objectives

1. To emphasize that everything in our environment is related to everything else and that, at least ecologically speaking, everything we do has an effect on someone or something else.
2. To lead students to realize that everyone contributes trash and garbage to our communities' solid waste stream and that, when properly managed (collected, transported, processed, and disposed of), these discards do not pollute. Improperly managed, these waste products represent what has been called the third pollution (after air and water).
3. To clarify aspects of our growing municipal trash and garbage challenge, particularly in terms of increasing volume, diminishing resources, and mounting management costs. To distinguish between municipal and other forms of solid waste (industrial, commercial, mineral, and agricultural).
4. To explore the impact of our increasingly populous, affluent, convenience-demanding, and health-conscious society on the problem of solid waste and the need for effective management.
5. To understand that litter, which occurs outside the solid waste collection system, represents a small but highly visible portion of our municipal solid waste load.
6. To encourage student activities and involvement that will help students plan and support action to protect the environment, conserve limited resources, and improve solid waste management.

II. COLLECTION AND TRANSPORTATION

A. Objectives

1. To be aware of how trash and garbage are handled after they have been left to be hauled away. To know how they are conveyed and what becomes of them.
2. To understand that a disproportionate amount of money (nearly 80 percent of community refuse expenditures) and manpower is expended on the collection and transportation of solid wastes alone.
3. To be aware of how outmoded collection methods add to municipal costs and health and environmental problems.
4. To examine recent technological and managerial developments that make it possible to reduce the problems and costs of refuse collection.

III. DISPOSAL

A. Objectives

1. To emphasize how in most cases the two primary methods of disposal (open dumping and burning; substandard incineration) cause pollution, add to the costs of health and environmental protection, and waste valuable resources.
2. To become aware of how local economic, political, and social problems are related to solid waste disposal and how local situations differ.
3. To learn about improved methods for reducing waste volume and disposing of the residue (sanitary landfill, controlled incineration, pyrolysis, etc.)

IV. RESOURCE RECOVERY

A. Objectives

1. To develop the understanding that through resource recovery we can utilize materials from solid waste and thus conserve depletable resources for the future.
2. To understand that municipal solid waste is a vast national resource of materials and energy and that sufficient technology already exists to recover a much greater segment of these precious resources than we are now extracting.
3. To be familiar with the most significant resource recovery techniques and systems that are now available or in development.
4. To understand that, although proper solid waste management can turn a national problem into an economic opportunity, lasting resource recovery is possible only if the value derived from its use exceeds the cost of separation or processing. The challenge is largely economic, and therein lies both the problem and the solution.

V. SOLID WASTE MANAGEMENT SYSTEMS

A. Objectives

1. To understand that solid waste management must be dealt with through a total systems approach comprising the steps of home collection, separation, recovery, and conversion and that several promising systems are already in operation, in addition to those in development.
2. To understand that although new systems are emerging, no single solution is likely to be adaptable to every situation.
3. To identify and remove the stumbling blocks that prevent us from realizing wide-scale resource recovery today.
4. To understand that technological problems may be solved more readily than economic ones.
5. To determine whether your community has a solid waste management plan that is far-reaching and comprehensive rather than shortsighted and piecemeal.

ENVIRONMENTAL CAREERS

This section presents information on the careers that will soon be required to support our growing involvement with environmental problems and the new industries that are developing in response to those problems. The section is intended as a source of counseling information to further stimulate those students who have already expressed some interest in environmental matters as a possible career field.

Changes in career opportunities. In this era of "future shock," scientific advances and technological developments sometimes seem to be coming upon us a little too fast. Nevertheless, they are helping to meet new needs, and they bring new benefits. Today, the large-scale efforts of Americans to clean up their polluted environment and to deal more effectively with the collection, disposal, and recycling of solid wastes are leading to the creation of new systems, new approaches, new management, and new jobs. Earlier, the Space Age created a similar new round of jobs and opportunities. Odom Fanning, author of *Opportunities in Environmental Careers*, predicts that the number of those employed in environmental management will double in ten years, resulting in severe shortages of trained men and women to fill these jobs unless adequate provision for training is made.

What are the choices? What can young people do to help solve the environmental problems, especially those relating to solid waste management and resource recovery? Many students are asking these and other questions, such as what the educational requirements for various jobs are and where such courses are available.

The environment career spectrum is broad, with many possible types of occupations—working indoors or outdoors, doing research or making decisions, designing equipment or operating it. The range of careers covers many skills and levels of training. Some students may wish to enter a career that is directly concerned with conservation, with solid waste management, or with pollution control and resource recovery. But these are not the only fields in which important contributions can be made and in which the individuals may experience a sense of accomplishment, personal fulfillment, and gratification. To play an active role in meeting the environmental pollution challenge, students should begin planning now.

Fields of study related to the environment. The following list points to key areas of study for preparation for environmental occupations:

Basic Sciences

Physics	Ecology	Hydrology
Chemistry	Meteorology	Bacteriology
Geology	Limnology	Metallurgy
Biology		

Applied Sciences

Building architecture	Agronomy
Landscape architecture	Statistics

Health Services

Bacteriology	Preventive medicine
Epidemiology	Public health
Toxicology	

Social Sciences and Services

Sociology	Anthropology	Forestry
Law	Social work	Recreation
Education	Urban planning	Writing
Economics	Soil conservation	Publicity

Engineering

Chemical engineering	Metallurgy
Civil engineering	Design engineering
Electrical engineering	Production engineering
Mechanical engineering	Engineering support services

The demand for environmental careers. In meeting the environmental challenge, scientists, engineers, lawyers, public health officers, public administrators, and members of many other professions will play an ever-widening role. These and similar careers require men and women with professional training, usually a master's or doctor's degree in one of these fields.

It is in this category that we find our scientists—the chemists, physicists, and many others. They are basically involved in research and development, working toward new technological breakthroughs. Their occupations often lead to high-ranking careers in research and management. Here also are engineers working on the manufacture, fabrication, and end use of existing materials, and on the development of new materials, processes, and equipment.

Almost all these professionals require assistants whose jobs, though interesting, challenging, and rewarding, require less academic training. This job category, called paraprofessional, includes laboratory and instrument technicians, repair and maintenance people, computer specialists, and a wide range of skilled operators of complicated equipment. Some people in these jobs may have been educated in junior and community colleges or technical institutes, and others through part-time day courses or evening study programs. Still others may enter the job market on the basis of informal apprenticeship and receive on-the-job training.

Opportunities are also available in the field of environmental education. Even schools without specific curricula or courses in ecology have enriched their traditional programs to make them more relevant to environmental concerns. Many colleges have introduced degree programs in environmental studies. The following institutions also offer graduate studies in environmental protection, specifically in the solid waste area:

University of Florida
Georgia Institute of Technology
University of Hawaii
University of Illinois
University of Kansas
University of Michigan
Rensselaer Polytechnic Institute
Drexel Institute of Technology
University of Houston
University of Texas
West Virginia University

One field that is expanding very rapidly at present is that of pollution control. Environmental pollution is usually divided into three broad categories—air, water, and solid waste. Important jobs are being done in all three areas, and many more jobs are being created as environmental improvement programs get under way.

Air pollution control. A recent report by the U.S. Environmental Protection Agency (EPA) points to the growing employment in the control of air pollution. There are now a total of 264 air pollution control agencies in the United States, employing over 5000 people in the following categories:

Job Category	Percent
Inspector	18.5
Engineer	17.2
Technician	10.4
Specialist (subprofessional)	7.6
Chemist	7.2
Aide	2.1
Meteorologist	1.1
Administrative/clerical, supervisory, and all others	36.0

As indicated by college degrees, employees' major fields of study as reported by the air pollution agencies are:

Field of Study	Number of Degrees
Engineering	1204
Biological and physical sciences	910
Health professions	114
Business and commerce	93
Social sciences	64
Education	64
Agriculture	58
Humanities and liberal arts	54
Mathematics	42
Law, medicine, general science, and unspecified fields	433
Total	3036

Water pollution control. The Federal Water Pollution Control Administration, reporting to Congress in 1967, estimated the need for professionals, technicians, and operators in water pollution control at that time to be 45,000. The estimated need by the end of 1972 would be 111,500, an increase in five years of 66,500. These figures include only those jobs requiring college or special post-high-school education and training. If all jobs in water pollution control had been included, these figures would be more than doubled.

The following table, compiled in 1970 by the Water Pollution Control Federation, shows an estimate of employment requirements in four broad categories:

Category	1970	1975
Professionals	59,400	89,000
Technicians	42,900	61,500
Operators	66,000	93,000
Related blue-collar workers	141,000	201,500
Total	309,300	445,500

In this category of pollution control, plant operation is a major employment area. As such, it is interesting to note the general knowledge and skills required to move to the top of the ladder in plant supervision:

mechanical and electrical equipment operation and maintenance
communications
basic physics
basic chemistry
fundamental and applied mathematics (through algebra)
general science
engineering drawing (plan-reading)
laboratory analysis of water and sewage
hydraulics
instrumentation
basic public health
management and administration

As you can see, most of these areas require more than a little academic training.

More specific information on careers in water pollution control can be found in the U.S. Department of Health, Education and Welfare Technical Education Program Series No. 11 (OE-80057) titled "Water and Wastewater Technology," which is available from the U.S. Government Printing Office, Division of Public Documents, Washington, D.C. 20402. The publication contains a suggested two-year post-high-school curriculum.

Solid waste management and resource recovery. Our nation's solid waste is a vast resource of materials and energy. We can no longer afford to ignore it while we deplete our natural resources and spoil our land and water with what we call wastes but what are really riches. There is sufficient technology today to recover a much greater segment of these resources than we are now extracting. And we will be able to do even more in the future than we can do today.

We know what we want to do—conserve natural resources, preserve environmental quality, and improve efficiency of solid waste management. Now is the time to begin. We are already burning and burying more resources than we can afford to lose, and we already have the knowledge and technology for reusing them. We can and we must recover these needed resources as quickly as possible. But the task will require the efforts and energies of great numbers of men and women with varying degrees of skills and education.

The education needed for environmental careers. The following table presents some of the professional careers that can be specifically involved with solid waste management and resource recovery.

Position	Years of College Training
Civil engineer	4
Mechanical engineer	4
Electrical engineer	4
Chemical engineer	4
Biochemist	4–6
Environmental engineer	4–6
Physicist	4–6
Economist	4–6
Facility manager	4–6
Statistician	4
Business administrator	4–5
Professional sanitarian	4–5
Research biologist	7–8
Research chemist	7–8
Research ecologist	7–8

However, it should be emphasized that interesting and rewarding careers are not solely for professionals and are not available only to the college graduate. In the past ten years a revolution has occurred in science and technology, creating a new job market. The demand for people with technical skills is growing twice as fast as any of the other job categories. According to the U.S. Office of Education there are not enough applicants to fill the technical positions now open. HEW estimates that well over a million more of these jobs will open up by 1975. For anyone with a good scientific or technical education the chances for immediate employment are very good.

A technical career does not require four years of college training. A person can receive the necessary background and training at a junior or community college or a technical institute in two years. The table below lists information on technical careers that now exist in the resource recovery field. It should be noted that all the training required for these jobs can be obtained in a community or junior college or a technical institute and that many such schools offer courses in environmental technology.

Position	Years of Training in a Technical School
Laboratory aide	1–2
Vacuum system operator	1–2
Electric generator technician	1–2
Pyrolysis reactor technician	1–2
Chemical laboratory technician	2–3
Electronic technician	2–3
Electromechanical technician	2–3
Fire protection specialist	2–3
Industrial production technician	2–3
Mechanical design technician	2–3
Sanitation control technician	2–3

It is also true that a great many nonprofessional, nontechnical careers will be required. Local governments need workers in waste collection and disposal, waste and sewerage systems, air pollution regulation, sanitation programs, and many other categories. The table below lists job opportunities that focus on waste management and resource recovery. Some on-the-job training is available in all these positions.

Position	Months of Training Beyond High School
Sanitation worker	none
Bulldozer operator	none
Sanitary landfill operator	3–6
Shredder operator	3–6
Conveyor operator	3–6
Compactor operator	3–6
Incinerator operator	3–6
Compost operator	3–6
Magnetic separator operator	6–9
Hydrapulper operator	6–9
Loader operator	6–9
Blue-collar worker	none

Salary levels in environmental careers. Careers in ecology can be rewarding from the viewpoint of salary as well as personal gratification. Salary levels have been rising in recent years in response to the increasing demand for talent.

A doctoral degree in an environment-related profession can usually command a beginning salary in the $7200 to $11,000 range. For a bachelor's or master's degree the range is from $5000 to $7000. An annual salary of $8400 is about average for state, county, and city positions in this field. Of course, the salary for a particular job will vary from place to place and according to the responsibility of the position. Salaries for ecology officers or college-trained employees with a few years of experience are substantially higher, rising to more than $25,000 annually at advanced levels.

The starting salaries for people without college degrees, usually called nonprofessionals, can be divided into the following categories:

Technician. A qualified technician can enter service in government or nongovernment jobs at about $6200 per year. It should be noted that often the technician and the professional may start at nearly the same salary, but because of a broader educational and training background the professional will frequently advance more rapidly and to a higher level than will the technician.

Aide. Aides work at a variety of productive tasks that help both the technician and the professional. They can enter careers at salaries in the $4500 to $5000 range and, with a few years' experience, move up to the $7500 to $10,000 range.

Clerk. Clerks are support personnel who do clerical jobs and staff work. They usually enter service at the $4500 to $5000 range.

Skilled worker and laborer. The pay scale for people in trades and crafts is based on rates paid by private businesses in the area where the job is located. Starting pay depends on the particular trade or skill, and varies from $400 to $700 per month. Some workers can command even higher salaries if the skills involved are in demand because of a short supply.

Of course, as the cost of living and the job markets change, these salary ranges will also vary.

The environment: A life's work. Naturally, this description of environmental careers has provided only an introduction to the important subject of careers in ecology. The point to emphasize is that, since virtually every human activity affects the environment, nearly every type of work can be directly or indirectly related to environmental control and improvement.

A second point is that the processes of thinking about the environment and planning for a career can proceed simultaneously and with mutual benefit in your students' minds. A student taking part in a voluntary recycling campaign may, as a result of that experience, discover a new awareness of chemistry or engineering as a life's work.

The following sources have available on request further information about environmental careers:

American Anthropological Association
1703 New Hampshire Avenue, N.W.
Washington, D.C. 20009

American Chemical Society
1155 Sixteenth Street, N.W.
Washington, D.C. 20036

American Federation of Information Processing Societies
201 Summit Avenue
Montvale, N.J. 07645

American Institute of Biological Sciences
200 P Street, N.W.
Washington, D.C. 20036

American Institute of Planners
917 Fifteenth Street, N.W.
Washington, D.C. 20005

Conservation Foundation
1250 Connecticut Avenue, N.W.
Washington, D.C. 20036

Ecological Society of America
Oak Ridge National Laboratory
Oak Ridge, Tenn. 37831

Environmental Science Center
5400 Glenwood Avenue
Minneapolis, Minn. 55422

Keep America Beautiful, Inc.
99 Park Avenue
New York, N.Y. 10016

National Audubon Society
1130 Fifth Avenue
New York, N.Y. 10028

National Health Council
1740 Broadway
New York, N.Y. 10019

National Home Study Council
1601 Eighteenth Street, N.W
Washington, D.C. 20009

National Sanitation Foundation
P.O. Box 1468
Ann Arbor, Mich. 48106

Occupational Education Project
American Association of Junior Colleges
One DuPont Circle
Washington, D.C. 20036

Office of Environmental Sciences
Smithsonian Institution
Washington, D.C. 20560

U.S. Department of Health, Education and Welfare
Office of Education
Washington, D.C. 20202

U.S. Department of the Interior
Washington, D.C. 20240

U.S. Environmental Protection Agency
Washington, D.C. 20460

Urban Coalition
2100 M Street, N.W.
Washington, D.C. 20037

Instructional Resources

I. SOLID WASTE: A GROWING PROBLEM

A. ENVIRONMENT—GENERAL REFERENCES

1. American Association of Museums. *Museums and the Environment: A Handbook for Education.* Arkville Press, 1971.
A distinguished committee of the American Association of Museums has supervised this collection of practical, effective, and economical exhibit ideas. The how-to-do-it, illustrated instructions are complete even to the color scheme. The discussion of "Environment, Population, Pollution" develops the themes for the exhibits.
2. American Iron and Steel Institute. *The Story of Environment and Industry.* Education Department, 1000 Sixteenth Street, N. W., Washington, D. C. 20036.
This 20" x 30" chart is a simplified introduction of the types of environmental pollution, the history and economics of the problem, the causes and cures, and environmental career opportunities.
3. Conservation Education Association. *Directory of Degree Programs Related to Conservation, Ecology, Environmental Education, Environmental Science, Outdoor Education, and Natural Resources.* Danville, Ill.: Interstate Printers and Publishers, Inc., 1971.
This directory provides information on courses available in the field of environmental studies at institutions of higher learning throughout the country. The pamphlet is arranged alphabetically by states.
4. Council on Environmental Quality. *Environmental Quality: The First Annual Report of the Council on Environmental Quality.* Washington, D. C.: U. S. Government Printing Office, August, 1970.
In this report a broad range of issues and problems are considered. Included are the sources, costs, and effects of air and water pollution; pollution from solid wastes, pesticides, radiation, and noise; federal state, and local antipollution programs in the major pollution categories; the problems of land use; international cooperation on environmental problems; and a discussion of present and future environmental needs.
5. __________. *Environmental Quality: The Second Annual Report of the Council on Environmental Quality.* Washington, D. C.: U. S. Government Printing Office, August, 1971.
This report presents an overview of federal, private, state, and local activities in the environmental field. It deals in depth with two fundamental aspects of environmental quality—economics and legal developments—and reviews recent developments related to these subjects.
6. __________. *Environmental Quality: The Third Annual Report of the Council on Environmental Quality.* Washington, D. C.: U. S. Government Printing Office, August, 1972.
This most recent report of the Council on Environmental Quality discusses the development of environmental indices; the need for and problems in forecasting the future; international aspects; federal, state, and local activities; the National Environmental Policy Act; the costs and economic impacts of environmental improvement, and national parks. A perspective of the environment in 1972 is also presented.
7. Dow Chemical Company. *Environmental Involvement: A Teacher's Guide.* Barstow Building, 2020 Dow Center, Midland, Mich. 48640.
Projects for increasing student awareness of the environmental quality challenge are the basis of this booklet, which also includes an annotated bibliography.
8. Fanning, Odom. *Opportunities in Environmental Careers.* New York: Universal Publishing and Distribution Corporation, 1971.
Opening with a general review of environmental problems, this book goes on to outline what is now being done in informal and formal education on the environment, what is needed, the career possibilities, and the institutions offering training in these fields. The book includes a bibliography and other sources of information.
9. Halacy, D. S., Jr. *Now or Never: The Fight Against Pollution.* New York: Four Winds Press, 1971.
This book takes a broad look at all pollution problems and the steps being taken to solve them.
10. National Academy of Sciences. *Waste Management and Control.* Publication 1400, prepared for the Federal Council for Science and Technology. Washington, D. C.: Printing and Publishing Office, National Academy of Sciences, 1966.
This report describes in depth the problems of pollution: the legal, legislative, and institutional problems and areas of inadequacy in the fields of research, education, and technology. Improved approaches and methods that should be investigated and recommendations for meeting future demands are also discussed.
11. National Industrial Pollution Control Council. *National Industrial Pollution Control Council*

Reports. Washington, D. C.: U. S. Government Printing Office, 1971.
Thirty subcouncils, composed of members from the engineering, mining, manufacturing, and goods distribution sectors of American industry, report to the Council. These subcouncils identify problems of pollution control and abatement within the various industries and determine the progress that is being made. They have issued the following pamphlets on the results of studies pertinent to the solid waste field: *The Disposal of Major Appliances, Glass Containers, Paper, Plastics in Solid Waste, Rubber, Wood Products, Junk Car Disposal, and Deep Ocean Dumping of Baled Refuse.*

12. U. S. Environmental Protection Agency. *Environment Film Review.*
Lists, classifies, describes, and rates 627 films covering all major environmental topics. Ordering information and prices are included with each film description. Indexed.

13. ________________. *Your World, My World—A Book for Young Environmentalists.* Stock No. SN 3300-00470. Washington, D. C.: U. S. Government Printing Office.
Written primarily for young people of elementary and junior high school age, this booklet attempts to instill an understanding of environmental problems, to explain some of the efforts that are being made by EPA, and to suggest actions that can be taken by the young to help achieve a better environment.

B. SOLID WASTE—GENERAL REFERENCES

1. Alexander, Tom. "The Packaging Problem Is a Can of Worms." *Fortune*, June, 1972.
This article explores the current trends in packaging, the problems involved in packaging disposal, and the possible solutions.

2. Aluminum Association. *The Story of Aluminum.* New York: The Aluminum Association, 750 Third Ave., New York, N.Y. 10017.
This illustrated pamphlet relates the history of aluminum and describes the aluminum-making process.

3. American Iron and Steel Institute. *The Making of Steel.* American Iron and Steel Institute, 150 East 42nd Street, Mobile Bldg., 38th Floor, New York, N.Y. 10017.
A detailed description of the steel-making process is given in this book.

4. Bureau of Mines, U. S. Department of the Interior. *Bureau of Mines Research Programs on Recycling and Disposal of Mineral-, Metal-, and Energy-Based Solid Wastes,* by Charles B. Kenahan and Einar P. Flint. Information Circular No. 8529. Washington, D. C.: U. S. Bureau of Mines, 1971.
The Bureau of Mines, through its own facilities and its grant and contract programs, is sponsoring a wide range of solid waste research projects. Projects in progress, some results from completed research, and areas for further study are discussed in this document. A lengthy bibliography is also included.

5. Clark, Roger N.; Hendee, John C.; Burgess, Robert L. "The Experimental Control of Littering." *The Journal of Environmental Education.* Winter, 1972.
A technical discussion summarizes previous litter research before outlining new approaches to fighting litter—including methods which use incentive approaches.

6. Glass Container Manufacturers Institute, Inc. *The Story of Glass Containers.* New York: Glass Container Manufacturers Institute, Inc., 1130 17th Street, N. W., Washington, D. C.
The history of glass, how glass containers are made, and how glass bottles affect the environment are discussed in this illustrated pamphlet. At the end of each section a list of classroom activities is also included.

7. Hunter, D. *Papermaking: The History and Technique of an Ancient Craft.* 2nd ed. New York: Alfred A. Knopf, Inc., 1957.
This book describes the evolution of paper, which has been made and used for hundreds of years.

8. Keep America Beautiful. *Guide to Mechanical Litter Removal Equipment.* Keep America Beautiful, Inc., 99 Park Avenue, New York, N.Y. 10016.
This pamphlet presents basic information about mechanical devices currently available for removing litter from highways and urban areas.

9. ________________. *Litter Laws.* Keep America Beautiful, Inc., 99 Park Avenue, New York, N.Y. 10016.
This pamphlet looks at existing antilitter laws, discusses problems of enforcement, and gives guidance for updating and improving these laws.

10. "New Drive to Get Rid of Trash." *U. S. News and World Report,* June 7, 1971.
Various techniques and programs being used for solid waste disposal and recycling, as well as problems encountered by these industries, are reviewed in this article.

11. Schmidt, J. H. *A National Survey of Litter Law Enforcement.* This publication was prepared for Keep America Beautiful by the International Association of Chiefs of Police. Gaithersburg, Md.: The International Association of Chiefs of Police, September, 1971.
This publication analyzes the results of a national survey of chiefs of police on littering. A description of the project, discussion of judicial enforcement

practices in different areas of the country, limiting factors for arrests and convictions for littering, and recommendations by the police officials for improved litter-law enforcement are presented here.

12. Small, William E. *Third Pollution: The National Problem of Solid Waste Disposal.* New York: Frederick A. Praeger, Inc., 1971.
Many facets of the solid waste problem, including collection and disposal technology; resource recovery; volume and disposal of urban, agricultural, mining, and energy wastes; and the junk auto problem are discussed in this book. Graphs and a lengthy bibliography are also included.

13. Society of the Plastics Industry. *The Plastics Industry and Solid Waste Management.* New York: Society of the Plastics Industry September, 1970.
This paper covers a broad range of subjects: plastics in solid waste; ecological benefits of plastics; the litter problem; the role of government; methods of waste disposal and the reaction of plastics to the various methods of disposal; the need for biodegradability and ways to reuse plastics; and SPI's solid waste activities.

14. Uniroyal, Inc., Uniroyal Chemical. *Rubber Reuse and Solid Waste Management.* by Robert J. Pettigrew and Frank H. Roninger. Report SW-22c, Contract No. PH 86-68-208, prepared for the U. S. Environmental Protection Agency, Office of Solid Waste Management Programs. Washington, D. C.: U. S. Government Printing Office, 1971.
Part I of this study on the fabricated rubber products industry discusses the history of the industry, future trends, divisions of the industry, industry disposal costs, and recommendations for future disposal needs. Part II of the study discusses the waste rubber product disposal problem, the present status of and future trends in waste reuse, and future areas of collection and potential reuse. A glossary, a bibliography, patent information, and several tables and figures are also given.

15. U. S. Department of Health, Education and Welfare. Public Health Service. *The National Solid Waste Survey: An Interim Report.* by Ralph J. Black; Anton J. Muhich; Albert J. Klee; H. Lanier Hickman, Jr.; and Richard D. Vaughan. Cincinnati: Bureau of Solid Waste Management, 1968.
A need for reliable information on solid wastes led to the 1968 national survey of community solid waste practices reported on in this document. The report analyzes community practices in collection and disposal, and it provides many basic statistics on the solid waste problem.

16. U S Environmental Protection Agency. *Solid Waste Management: A List of Available Literature.* Report SW-58-14. Cincinnati: Solid Waste Management Publications Distribution Unit, Environmental Protection Agency.
This listing of publications in the solid waste field that have been collected or published by the Environmental Protection Agency is issued periodically.

II. COLLECTION AND TRANSPORTATION

A. Bogue, M. DeVon. "Clean and Green Solid Waste System in Alabama Is Widely Copied." Reprinted, with permission, by the Office of Solid Waste Management Programs, U.S. Environmental Protection Agency, from *Waste Age*, September-October, 1970. Washington, D.C.: U.S. Environmental Protection Agency, 1971.
This article describes a county-wide collection system in Chilton County, Alabama, that was designed to improve rural collection of solid waste. Citizens bring their refuse to bulk storage containers for regular pickup, and the refuse is then sanitary-landfilled.

B. "Garbage Gets a Glamour Image." *Business Week*, March 4, 1972.
Chains of garbage collection and disposal operations have been started by six parent companies across the country. The methods used by these companies and the economic advantages of large-scale collection and disposal are briefly discussed in this article.

C. Johansson, Bertram B. "Whisking the Garbage." *Saturday Review*, July 3, 1971.
In the Swedish city of Sundbyberg the collection of trash is handled by a vacuum tube through which a high-velocity air stream conveys trash to an incinerator for disposal. This system, which is being used now at several sites in the United States, is described in the article.

D. Kazan, Nick. "Can Free Enterprise Speed Up Our Garbage Collection?" *New York Magazine*, July 12, 1971.
The advantages of private refuse collection in San Francisco (where shares in the companies are owned by working and retired garbage men) are discussed in this article. This approach is shown to be efficient, good for morale, and economically feasible.

E. "Out of Trash and Garbage, Some Answers—Scottsdale, a Small City, Leads the Way." *The Struggle to Bring Technology to Cities.* Washington, D.C.: The Urban Institute, 1971.
With the design of a new refuse collection vehicle, "Son of Godzilla," that requires only one man to drive the truck and pick up the trash, Scottsdale,

Arizona, now has a futuristic trash collection operation. The preliminary work required for the project and the operation of the new collection service are described in this chapter of the report.

III. DISPOSAL

A. American Public Works Association. *Municipal Refuse Disposal*. Danville, Ill.: Interstate Printers and Publishers, Inc., 1970.
This comprehensive manual on disposal practices reviews past and present practices, describes and analyzes the best current practices, surveys the costs, and discusses administrative and management problems. It is an excellent "how-to" book for municipal officials and a mine of information for the interested layman.
B. General Motors Corporation. *How to Harvest Abandoned Cars*. Detroit, Mich.: General Motors Corporation, 1971.
This booklet contains information on collecting and processing abandoned cars. The description of the General Motors campaign conducted in Traverse City, Michigan, provides guidelines for communities that want to organize and finance their own campaigns to clean up abandoned cars.
C. Honeywell Presidential Division. *Electronic Air Cleaning: Theory and Fundamentals*. Electronic Air Cleaner Inquiries G 2118, 2701 Fourth Avenue South, Minneapolis, Minn. 55408.
This technical and detailed booklet, adapted from training material for air-conditioning engineers, discusses air pollutants and their means of removal—especially by means of electrostatic precipitators. Includes data on filler types, ozone and odor control, and particle characteristics.
D. U.S. Department of Health, Education and Welfare, Bureau of Solid Waste Management. *Sanitary Landfill Facts*, by Thomas J. Sorg and H. Lanier Hickman, Jr. Report SW-4ts, Public Health Service Publication No. 1792. Washington, D.C.: U.S. Government Printing Office, 1970.
E. ________________. Public Health Service. *Incinerator Guidelines—1969*, by Jack De Marco, Daniel J. Keller, J. Leckman, and James L. Newton. Public Health Service Publication No. 2012. Washington, D.C.: U.S. Government Printing Office, 1969.
Because many independent sources have contributed to the development of incinerator technology, incinerator design and operation are not standardized. This publication, by describing the best in incinerator technology, contributes to greater standardization in incinerator development. Desirable performance characteristics, the process of incineration, and the "state-of-the-art" are discussed. Graphs, diagrams, tables, and references are included.
This document presents basic information on sanitary landfills, such as planning, design, operation, and public health aspects. Illustrations, references, and a bibliography are also included.
F. U.S. Environmental Protection Agency. *Mission 5000: A citizen's Solid Waste Management Project*. Stock No. 5502-0087. Washington, D.C.: U.S. Government Printing Office, 1972
The goal of Mission 5000, sponsored by EPA, is to eliminate the open dump and to replace it with modern solid waste handling facilities. This booklet describes various methods of solid waste management and recovery that can be utilized by communities that wish to eliminate open dumps and suggests ways in which citizens can influence adoption by their communities of policies and practices that will help make Mission 5000 a success.

IV. RESOURCE RECOVERY

A. American Forest Institute. *Recycling Questions and Answers*. American Forest Institute, 1619 Massachusetts Ave., N.W., Washington, D.C. 20036.
This pamphlet, using a question-and-answer format, discusses recycling in the paper industry.
B. American Paper Institute. *Background Information on Recycling Waste Paper*. New York: American Paper Institute, 260 Madison Ave., New York, N.Y. 10016.
This pamphlet provides data through 1969 on grades of waste paper, their disposability, products which may be made from recycled waste paper, and the potential of waste paper as a contributor to the nation's wood fiber supply.
C. American Public Works Association. *Refuse Collection Practice*. Danville, Ill.: Interstate Printers and Publishers, 1966.
This book is an informative source of materials on the collection and transportation of refuse. Equipment, methods of collection, costs and financing, and special problems of personnel involved in refuse collection are a few of the topics discussed. Many illustrations and bibliography references are included.
D. Battelle Memorial Institute. *Recovery and Utilization of Municipal Solid Waste*, by N. L. Drobny, H. E. Hull, and R. F. Testin. Report SW-10c, Contract No. PH 86-67-265, prepared for the U.S. Environmental Protection Agency, Office of Solid Waste Management Programs. Washington, D.C.: U.S. Government Printing Office, 1971.
This report is a source book of existing technology for three areas of solid waste recovery: size

reduction, separation, and recovery (including reuse and conversion). Descriptions of various methods of resource recovery, their costs, and their performance characteristics are included, along with references, figures, tables, and illustrations.

E. Connor, William J. "Shredding and Metal Salvage Give Landfill New Life." *The American City*, April, 1973.
This article describes how New Castle County, Delaware, uses both methods to lower landfill costs and to help pay for its new refuse processing plant. There is also discussion of the other reclamation possibilities: for example, the biodegradable portion of the shredded scrap looks promising as a compost additive for the local mushroom industry.

F. DeVito, Alfred. " 'Found' Science Equipment." *Science Activities*, January, 1973.
To assist the instructor in assembling some of the hardware necessary for the teaching of science, the author has listed several materials that can be recycled from trash into an elementary science program.

G. Durmont, Raymond H.; Mikuska, James M. "A Practical Recycling Project." *Science Activities*, February, 1973.
An experiment for recycling aluminum lunch trays into secondary aluminum is described in this article. As a school recycling program, this activity offers an excellent example of departmental cooperation in solving environmental problems.

H. Franz, Maurice. "Municipal Garbage into Mushroom Soil." *Compost Science*, November–December, 1972.
A journal's description of how men, engineering know-how, and new equipment have teamed up in New Castle County, Delaware, and Kennett Square, Pennsylvania, to grow bigger and better mushrooms by using city garbage.

I. Grinstead, Robert R. "Bottlenecks, Part I." *Environment*, April, 1972.
Problems that are associated with the recovery of specific resources and with several recovery methods are presented in this article. The author discusses the qualities of the resources and of the methods of manufacturing that hinder recycling efforts and considers the potential amounts of resources available if resource recovery is practiced on a broad scale. Several charts and a comprehensive bibliography are included.

J.______. "Machinery for Trash Mining, Part II." *Environment*, May, 1972.
Part II outlines some of the technology by which various materials are recovered, assesses the current status of a number of systems, and discusses "bottlenecks" of resource recovery technology. Processes and systems discussed include incineration and residue separation by conventional methods, pyrolysis, composting, fiber recovery, and the use of refuse as boiler fuel. A list of references is included.

K. Hoffstrom, Jerry. "Demonstrating the Treatment of Sewage." *The American Biology Teacher*, May, 1973.
Teachers are increasingly called upon to inform their students about the most recent technologic means of improving the quality of the environment. One environment-enhancing task that has undergone important technologic change is sewage treatment. This paper tells how two recent advances in sewage treatment can be demonstrated in the high school laboratory.

L. Lesher, Dr. Richard L. "Tackling Resource Recovery on a National Scale." *Environmental Science & Technology*, December, 1972.
This article describes the concept developed by the National Center for Resource Recovery of a system for recovering valuable and reusable materials from our presently discarded urban solid waste.

M. Myer, Judith G. "Renewing the Soil." *Environment*, March, 1972.
This article covers a broad range of topics about composting, including the costs of composting; some of the problems that have confronted composting in this country, Europe, and the Middle East; a description of composting processes; the ecological effects of composting; a list of municipal refuse composting plants in the United States and their status, and examples of existing and proposed programs in this area. Several graphs and a bibliography are included.

N. "Refresh This Tired Earth with Compost." *Environmental Action Bulletin*, January 23, 1971.
This article describes methods for putting garbage to work, including: (1) burying it in pits or in future planting rows; (2) feeding it to earthworms; and (3) composting it with other organic materials.

O. Schatz, Albert, and Schatz, Vivian. *Teaching Science with Garbage*. Emmaus, Pa.: Rodale Books, Inc., 1971.
This publication suggests experiments that may be conducted in the classroom. Although composting on a miniature scale is emphasized, other subjects—such as using fats to make soap, constructing "mini" landfills, and studying the composition and volume of garbage—are also discussed. Illustrations, graphs, and a list of sources of information about composting garbage are also included.

P. Stein, Roy. "Recycling Paper: An Ecology Experiment." *Science Activities*, June, 1973.
This one-page article contains a laboratory

experiment on paper recycling.

Q. Sullivan, Kay. "The Redbook Handicrafter: 89 Things To Make Out of What You Were Going to Throw Away." *Redbook*, June, 1973.
An illustrated article contains 89 suggestions for ways to convert items headed for the trash can. Some are just that— suggestions— and students must develop the ideas themselves. Others provide enough basic information to get them started. Some give complete instructions.

R. "Turning Junk and Trash into a Resource." *Business Week*, October 10, 1970.
This article describes present methods of recovering value from waste and some current developments in producing the machinery to improve these methods.

S. U.S. Congress. Joint Economic Committee. Subcommittee on Fiscal Policy. *The Economics of Recycling Waste Materials*. 92nd Congress, First Session, November 8-9, 1971. Washington, D.C.: U.S. Government Printing Office, 1971.
This report, which contains statements by industry, government, and private organizations, covers a wide range of interests. Additional information submitted by the witnesses, as well as graphs and diagrams, is also included.

T. U.S. Environmental Protection Agency. *Composting of Municipal Solid Wastes in the United States*. Report SW-47r. Washington, D.C.: U.S. Government Printing Office, 1971.
This report discusses the results of an experimental composting project conducted jointly by the U.S. Public Health Service, The Tennessee Valley Authority, and Johnson City, Tennessee. Background information on composting and the technical and economic feasibility of this method of handling solid wastes are discussed. Tables, figures, and references are included.

U. *The Salvage Industry: What It Is—How It Works*. Stock No. 5502-00108. Washington, D.C. U.S. Government Printing Office.
This condensation is based on *Salvage Markets for Materials in Solid Wastes*, by Arsen Darnay and William E. Franklin, and was prepared for the Federal Solid Waste Management Program as a brief overview of the salvage industry. Included is a section entitled "Salvageable Commodities in Municipal Wastes."

V. Walter, Richard. "How to Compost Leaves and Turn Them into a Municipal Asset Instead of a Nuisance." The *American City*, June, 1971.
The author of this article contends that composting is what should be done with the annual leaf crop in a municipality, and describes the successful program of Maplewood, New Jersey.

V. SOLID WASTE MANAGEMENT

A. Citizens' Advisory Committee on Environmental Quality. *Community Action for Environmental Quality*. Washington, D.C.: U.S. Government Printing Office, 1970.
This booklet offers suggestions for practical action by municipalities and residents to improve many aspects of their environment.

B. National Academy of Sciences. *Policies for Solid Waste Management*. Report SW-11c, Contract No. PH 86-67-240, prepared for the U.S. Department of Health, Education and Welfare, Bureau of Solid Waste Management. Washington, D.C.: U.S. Government Printing Office, 1970.
As a result of the report *Waste Management and Control*, the Office of Solid Waste Management Programs asked the National Academy of Sciences to establish a committee on solid waste management. This committee would advise the Bureau on the feasibility of implementing the NAS-NRC recommendations related to solid wastes. The committee developed a new set of recommendations for policies for solid waste management; these recommendations are outlined and discussed in this report.

C. "Resource Recovery: A Positive Approach to the Solid Waste Problem." *Nation's Cities* June, 1972.
The potential of resource recovery, its role in solid waste management, and the National Resource Recovery Network being established by the National Center for Resource Recovery are discussed in this article.

D. *Solid Waste Disposal Act*. Title II, PL 89-272, 89th Congress, S.306, October 20, 1965, as amended by the *Resource Recovery Act of 1970*, PL91-512, 91st Congress, H.R. 11833, October 26, 1970. Washington, D.C.: U.S. Government Printing Office.
This legislation gives the federal government responsibility for research, training, demonstrations of new technology, technical assistance, and grants-in-aid for state and interstate solid waste programs. The amendment redirects emphasis from disposal to recycling, expands the grant and demonstration program, and creates a National Commission on Materials Policy.

E. U.S. Environmental Protection Agency. *The Challenge of the Environment—A Primer on EPA's Statutory Authority*. Stock No. 5500-0078. Washington, D.C. U.S. Government Printing Office.
The reorganization plan that established EPA in December, 1970, combined programs from 15 departments and agencies, and gave the Agency responsibility for air and water pollution control,

pes..cides, solid waste, radiation, and noise. This booklet summarizes the major legislation in each of these areas and explains the laws under which EPA has the authority and the responsibility to fulfill its mission—namely, to protect the environment. It is intended to help citizens better understand EPA's role.

F. *Citizen Action Can Get Results.* Stock No. 5500-10070. Washington, D.C. U.S. Government Printing Office.

From neighborhood cleanup campaigns to legal action against polluters, citizen involvement has become an integral part of the movement for environmental quality in the United States. Brief case histories of successful citizen campaigns are described in this pamphlet, which also contains suggestions for individual action.

G. *Finding Your Way Through EPA.*

A directory of key sources of information within EPA, including an up-to-date organizational chart and a listing of the regional offices and the National Environmental Research Centers.

H. ________________. *Groups That Can Help—A Directory of Environmental Organizations.* Stock No. 5501-00418. Washington, D.C.: U.S. Government Printing Office.

The increasing awareness of and concern for environmental problems facing us are reflected in the ever-growing number of organizations—national, regional, and local—working for the restoration and protection of the environment. This directory lists some of these groups and describes their operations and objectives. It is not a complete listing but a sampling of national nonprofit organizations that can be contacted by individuals seeking information and advice.

I. ________________. *Highlights—The Marine Protection, Research, and Sanctuaries Act of 1972 (Ocean Dumping).*

Explains the most significant provisions of the law that is aimed at regulating the dumping of pollutants into the oceans and ultimately putting an end to the practice.

J. ________________. *In Productive Harmony—Environmental Impact Statements Broaden the Nation's Perspectives.*

Discusses and explains the environmental impact statements required by the National Environmental Policy Act of 1969—what they are, when they are required, how they are prepared, who has responsibility for review—and assesses the effectiveness of the impact statement process in reducing environmental damage from federal activities.

K. ________________. *The Processing and Recovery of Jon Thomas—Cool Cat.* Stock No. 5502-0084. Washington, D.C.: U.S. Government Printing Office.

Jon Thomas, looking for his supper in a garbage can, accidentally falls into his community's solid-waste disposal system. The cat's odyssey through the processes of waste disposal illustrates for students as well as adults the basic methods of modern waste management.

L. ________________. *Symbol of Hope.*

This leaflet explains the origin and meaning of the official EPA insignia.

AUDIOVISUAL MATERIALS

CYCLES

13½ min., color, $200, free loan, 1971.

Glass Container Manufacturers Institute, Inc. Rent from: Association-Sterling Films, 866 Third Avenue, New York, N.Y. 10022.

The world of nature is a world of cycles—cycles of seasonal tides and time, of seasons with constant change, and continual renewal. This film survey of new recycling technology provides valuable background information on the solid waste problem and reveals how man is beginning to recycle the refuse of modern civilization.

THE GREEN BOX

17 min., color, $200, free loan.

Stuart Finley, Inc., 3428 Mansfield Road, Falls Church, Va. 22041. Rent from: National Medical Audiovisual Center (Annex), Station K, Atlanta, Ga. 30324. Order No. M-2097-X.

The people of Chilton County, Alabama, recall how they developed an outstanding container collection system. This system is now being adopted elsewhere.

IN THE BAG

19 min., color, $200, free loan.

Stuart Finley, Inc., 3428 Mansfield Road, Falls Church, Va. 22041. Rent from: National Medical Audiovisual Center (Annex), Station K, Atlanta, Ga. 30324. Order No. M-2091-X.

Describes the refuse sack system of collecting solid waste, which can provide better service and eliminate operational problems.

RECYCLING

21 min., color, $200, free loan.

Stuart Finley, Inc., 3428 Mansfield Road, Falls Church, Va. 22041. Rent from: National Medical Audiovisual Center (Annex), Station K, Atlanta, Ga. 30324. Order No. M-2118-X.

Shows existing techniques for recovering materials from solid waste and describes newly developed equipment and systems that may make recycling universal tomorrow.

SANITARY LANDFILL: ONE PART EARTH TO FOUR PARTS REFUSE
24 min., color, $97.75, free loan, 1969.
Rent from: National Medical Audiovisual Center (Annex), Station K, Atlanta, Ga. 30324. Order No. M-1740-X.
Presents all aspects of landfill planning and operation: site selection, equipment requirements, climate influences, operating procedures, topography, soil conditions, final planning, and ultimate use of the completed fill. Some of the detail is quite technical.

THE STUFF WE THROW AWAY
22 min., color, $200, free loan, 1970.
Stuart Finley, Inc., 3428 Mansfield Road, Falls Church, Va. 22041. Rent from: National Medical Audiovisual Center (Annex), Station K, Atlanta, Ga. 30324. Order No. M-2048-X.
Describes the massive problem of collecting and disposing of America's solid waste. It also illustrates a variety of new and improved techniques that are being investigated and demonstrated under provisions of the Solid Waste Disposal Act.

THINGS WORTH SAVING
13½ min., color, $65, free loan, 1972.
National Center for Resource Recovery, Inc., 1211 Connecticut Avenue, Washington, D.C. 20036.
Highlights the nature and magnitude of municipal solid waste management problems, defines litter as differing from solid waste and needing different solutions, shows present-day improvements in collection and disposal systems, relates the work of NCRR in developing systems to mechanically recover materials and to derive value from mixed trash and garbage, and promotes the concept of resource recovery.

THE THIRD POLLUTION
23 min., color, $225, free loan, 1966.
Stuart Finley, Inc., 3428 Mansfield Road, Falls Church, Va. 22041. Rent from: National Medical Audiovisual Center (Annex), Station K, Atlanta, Ga. 30324. Order No. AM-1404.
Dramatizes the nation's $4.5 billion-a-year problem of managing its solid waste. Burning refuse contributes to air pollution, and dumping it contaminates groundwater supplies. In addition, the collection and disposal of solid waste are expensive and technically challenging. This film describes the various alternatives that are available.

THE TROUBLE WITH TRASH
28 min., color, free loan
Caterpillar Tractor Film Library, 160 East Grand Avenue, Chicago, Ill. 60611.
Vivid portrayal of the positive features of landfill methods of solid waste disposal.

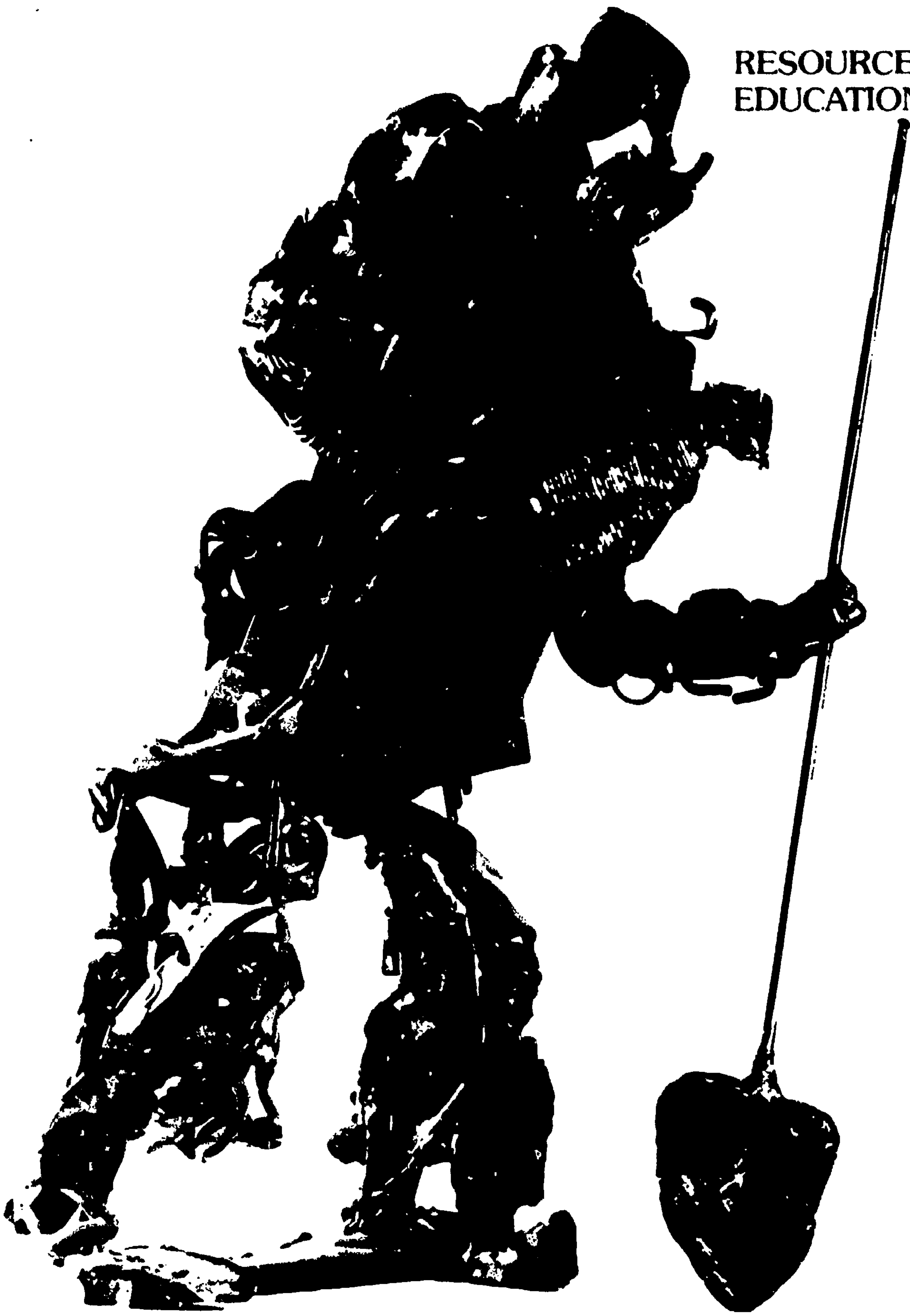
WE
28½ min., color, free loan.
Rent from: Bureau of the Census, SESA, U.S. Department of Commerce, Public Information Office, Room 2089, Federal Office Building #3, Washington, D.C. 20233.
Presents related statistics from the 1970 census and touches on a population on the move. Provides valuable factual perspective on the growth of the past decade.

WEALTH OF THE WASTELAND
26½ min., color, free loan.
Rent from: Motion Pictures, Bureau of Mines, U.S. Department of the Interior, 4800 Forbes Avenue, Pittsburgh, Pa. 15213.
Civilization's waste materials are noxious, unsightly, abundant, and potentially valuable. Besides showing that wastes are pollutants of land, air, and water, this new film points out that our vast tonnages of wastes are potential sources of valuable minerals that society needs today and will need even more in the future.

WOODLAND MANNERS
19 min., color, $84, free loan.
Rent from: Motion Picture Service, Office of Information, U.S. Department of Agriculture, Washington, D.C. 20250.
A national forest is the setting for a dramatic contrast between litterbugs and a well-behaved family cleaning up after a camping trip.

WORK IN PROGRESS
27 min., color, free loan.
Rent from: Association-Sterling Films, 866 Third Avenue, New York, N.Y. 10022.
Explains how the awareness of the industry to its responsibilities to the environment is leading to the use of improved pollution-control equipment. Touches on recycling, electrostatic filters, and new waste water facilities. Begins and ends with cartoon format.

RESOURCE RECOVERY
EDUCATION PROGRAM



RESOURCE RECOVERY AND YOU

RESOURCE RECOVERY EDUCATION PROGRAM

National Association of Secondary School Principals
1904 Association Drive, Reston, Virginia 22091

National Center for Resource Recovery, Inc.
1211 Connecticut Avenue, N. W. Washington, D. C. 20036

WASTE NOT

New Products and Energy From Our Garbage?

It seems every day someone reminds us of our fast changing world. A multitude of events at home and abroad are increasingly affecting the way we live, work and play. One cold winter morning, our clocks are set at Standard Time; the next day, we awake to the darker skies of Daylight Saving Time. The temperatures of our homes and school buildings are set six or more degrees lower during winter and air conditioner use is reduced during warm weather — — all because of the energy shortage. Not too long ago, money was the only apparent limit to how much of any product we used. Now, many of the things we want and use are in short supply, and sometimes not even available. More and more, we are being made aware of the shortages of materials and resources around the world.

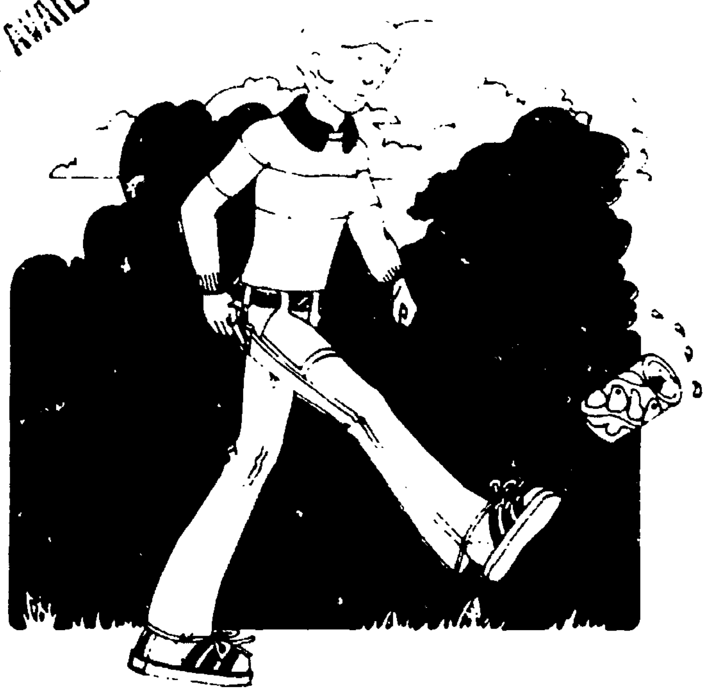
What may come as a surprise is a rather unlikely source of "raw materials" for making many of the products and fuels we use our daily trash and garbage! In this growing mass of discards is a vast assortment of valuable metals and minerals that, if separated, can be used along with other raw materials in the manufacture of new products. And, the combustible portion of our communities' waste represents a fuel that can help generate electricity and heat.

We have come to accept garbage as a negative, but necessary, by-product of our living. Everybody generates it. Until recent years, this refuse was only considered as something to be disposed of as quickly and inoffensively as possible. With greater concern about the environment, we began realizing that unless these discards are properly handled, they pollute air, water, and land. Further, we became more aware of the need to conserve our precious natural resources and recognized that in our trash cans there are many materials that can be recovered for new life — — if the means can be found to efficiently separate these valuable materials from the rest of the waste and from each other.

We are faced with two challenges: to better manage trash and garbage, thus protecting the environment; and to develop the mechanical processes to extract those things of value. This is Resource Recovery . . . the reclaiming of wealth from waste. Resource Recovery is an exciting concept, a new dimension to traditional practices of waste handling.

This program will enable you to learn more about the things we consume and throw away . . . about how communities can better handle this refuse . . . about the new efforts and systems soon to be built in many of our cities to recover important resources . . . and about how you can contribute to a better understanding of our garbage problems, solutions, and opportunities.

BEST COPY AVAILABLE



The snap . . . the spot . . . the kick . . . and with that, another can was lifted into a gentle arc. It seemed to have plenty of backspin to keep it on course. But before it had gone about ten yards, it began to lose power, sail aimlessly, and then drift off to the right. Something was wrong . . .

Mark Gamble obviously had a strong leg. A varsity soccer player who had also been asked to kick for the football team, he had walked home on this street nearly every afternoon for the past three years. Usually with the same group of kids from the neighborhood.

During all that time Mark had perfected a little ritual that only he could do. As the group walked along he would scan the gutters along the roadside for discarded litter. Spotting a bottle or can, he had a way of running up to it, nudging it with his foot so that it popped up on end, planting his left foot, and giving it a ride with his right instep. The can would come back to earth, slowly backspinning, some 20 yards away—dead ahead, every time. Mark was a real phenomenon.

Today, however, something was different. Everyone could feel it. And everyone knew why. They had all gone to an assembly in sixth period this afternoon. Today's topic had been the environment and how people were turning the face of the earth into a trash heap. Of course, there was nothing particularly new in that. They'd all heard it before. In fact, they'd even done something about the problem: collected newspapers for recycling, sorted bottles at the collection center, and even pulled mattresses and bald tires out of Trident Creek.

Today's film and discussion, however, had been something else. Their teachers had ended the discussion with a challenge to the whole class to think of how their future careers could help relieve the problem.

"They've got to be kidding!" was far and away the overwhelming response. After all, nearly all Mark's friends had big plans for themselves. Dorita wanted to be a lawyer; she'd never lost an argument for as long as anyone could remember. Tony, who was a superstar in science, was set on becoming a chemical engineer. The rest of Mark's friends had equally impressive plans—doctors, salesmen, heavy equipment operators, computer specialists, plumbers, architects, and so on.

As Tony put it, "I don't see how they can expect us to change our plans for our lives. Besides, I think my parents have something else in mind for me. I don't know about you guys."

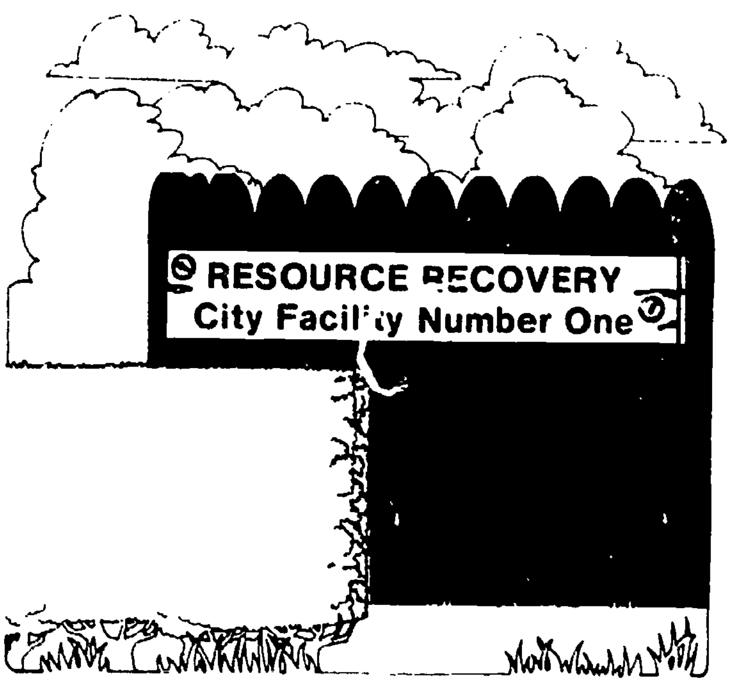
"What kinda off-the-wall talk is that?" It was Screwball, Dorita's cousin, talking; he was on the attack. "In other words, you're just going to sit back for life and say forget it? Even though you know that everything you buy or make will eventually end up in somebody's trash bin?"

"That's not all," Dorita added. "Think of all the things we throw away that end up in that smelly city dump. And nobody makes an effort to save the valuable metals and glass for recycling."

As for Mark, "The heck with it!" he thought. He liked to kick a ball, and he was good at it. With that kind of talent, he had more important things to do than worry about the environment or make other kinds of life plans. Obviously, the talk was getting too serious. Raising his books over his head in a gesture of farewell to his arguing friends, he loped up the steps to home.

Mark finished dinner quickly that night and seemed more annoyed than usual by having to take the kitchen trash can out into the chilly night air. "Funny," he thought, "I could swear that trash can was empty just before dinner. Whatever." Then he went back to his room and—after 25 deep knee bends— flopped on his bed in the dark. In all it had not been a good day. The last thing Mark remembered thinking about was how that afternoon's cartons and cans kept drifting off to the right.

One particular carton seemed to go much higher than usual. In fact, Mark could never remember having one go that high before. Slowly, slowly turning in the air, the sun glinting off it, the bottle came to rest in some of the softest, greenest grass he'd ever seen. Beyond the grass was a hedge—one of the most carefully trimmed hedges he'd ever seen. Behind the hedge, on a redwood fence, was a sign:



Mark could see several modern buildings, too. At his left a line of trash compactor trucks, all of them full, was passing through the main gate. They seemed to be waiting their turn for something.

Suddenly a voice spoke behind him: "Well, Mark Gamble! I never!" That voice. Turning, he saw it was Dorita and the rest of his school friends. "We haven't seen you for ages. Come on in with us. We're on our way to work."

"This is the first day the plant has been in operation. We're very proud of it," beamed Ryan.

"But . . . What is it?"

"Oh, Mark, can't you read? It's a resource recovery plant! Remember how we worried in school about the waste and environmental threat in our city's trash and garbage? That wasn't so long ago, was it? Now all that's changed—mostly because of recovery plants like this one located all across the nation." Dorita was obviously proud.

"From where we're standing, you can see the whole operation. Up to this end of the plant comes a steady stream of trash compactors from the city. They dump their loads, the factory machinery does its magic, and . . . Shazaam . . . out the other end of the plant go materials that can be used again: paper, glass, aluminum, and iron, to name only a few. You can see what we mean by 'resource recovery.' These materials are just as useful as natural resources to the manufacturers who plan to use the outputs of our plant. These products are the recovered resources that have been recycled."

"Come on, you're putting me on. Right? What products? It's all garbage, whatever you say. Especially when it gets all mixed up like that."

"No, Mark. Just look at what happens here in our plant. As the trash moves through the different stages of the recovery process, different machines and operators remove different products and gather them for resale to manufacturers. It's just the reverse of an assembly line at a manufacturing plant: here stuff is removed from the conveyor lines instead of being added to them."

"Dorita's right, you know, Mark," offered Ryan. "Our whole group of school friends has helped in starting this new system. That's why we're here on this first day. We were sure you'd show up, too."

"I knew it," Mark pretended to yawn. "You guys with your big career ideas! You should have known those plans would flop."

"That's where you're wrong," Tony said, "Each of us got the very job he'd been planning on. And each of us was able to contribute in his own special way."

"I can see I've been asleep longer than I first thought," muttered Mark.

"Yes, you have. I tell you what: we'll give you a tour of the whole place. You can see all the recovery processes and get an idea of just how many types of professional careers it has taken to get this resource recovery facility going. Dorita, why don't you lead the way?"

"Fine. Let's start right here. That truck is stopped on the weighing platform. There, the driver gets out and inserts his ID computer card into the reader. The facility computer automatically records information, such as the weight of the trash (after subtracting the weight of the truck when empty), the date and time, and the driver's route. By comparing this information with past information stored in the computer, the facility managers and planners can predict how much trash they'll have to work with that day and how much they're behind or ahead of schedule.

"You see, Mark, we're only at the first stage, and already we've involved computer operators and design people, programmers, industrial managers and work-flow analysts, computer manufacturers and trash compactor designers, and the people who designed and built the special concrete weighing platform."

"Before we get too far into these operations," put in Tony, "don't forget that the facility itself involves all kinds of jobs and people. Screwball, over there, has done a great job of landscape architecture, don't you think? And Ryan, your old friend, is now an industrial architect. He laid out the whole place so that it could be run efficiently and also be a comfortable place to work in. And while we're on the subject," Tony added, "Dorita is a lawyer with the city administration. She drew up the contracts to buy the land, fought to have the solid waste codes changed to make all this possible, and did a great deal of the administrative planning."

"Many of our other classmates also contributed during this important planning phase," Dorita went on. "Civil engineers did the site preparation studies, and mechanical engineers evaluated the equipment designs. Economists made estimates of the demand there would be for the facility's products, while chemical researchers studied the quality and value of those same products. Once those issues were settled, salesmen were required to canvass the nation for manufacturers who would buy and use the scrap. Even a team of public relations writers—you remember the kids from the school paper— were needed to tell people about the need for the new facility. You've got to remember that most people were still thinking of dumps, not of clean and attractive plants like this one.

"Just before construction began, a group of draftsmen, engineers, and surveyors began to work with Ryan's architectural firm to make detailed drawings so that the completed buildings would turn out to be what the planners had in mind.

"When construction began, a whole army of our friends joined in: foundation layers, carpenters, heavy equipment operators, bricklayers, pipe fitters, welders, electricians, and painters. And you have to remember that bankers, stockbrokers, and insurance men had already been involved in the planning.

"But the best part," continued Dorita, "is the way the technology and machines are working for our good. Let's get back to the tour.

"A city program will have already collected old newspapers and cardboard that homes and businesses have kept separate from their garbage. This waste paper can be easily recycled by mills into new paper products.

"The mass of mixed garbage and trash that's collected arrives at the resource recovery plant and is dumped. There, front-end loaders push the trash on large conveyor belts to be carried to one of the most important machines in the plant—the shredder—which grinds everything into small, uniform-sized pieces.

"From there, all the ground-up refuse goes into a machine called an air classifier. There, a blast of air blows up through the mixture to carry the lighter materials—shredded paper, food waste, leaves and lawn clippings, plastics and rubber—out the top into a storage bin. The heavier materials—rocks, dirt, metals, and minerals—drop to the bottom.

"Now, the light materials represent, happily, the combustible portion of garbage and can be used as a fuel to help generate steam for heat or electricity for homes, schools, and businesses. For cities that do not yet have systems to recover energy from waste, the light materials can be used in sanitary landfills.

"Getting back to the heavy materials that dropped out the bottom of the air classifier, a magnet removes the steel and other ferrous metals for recycling. The rest of the 'heavies' are processed through a variety of other machines and equipment to sort out and clean other valuable materials for sale to manufacturers for use in making new products. From such strange machines as 'rising current classifiers,' 'heavy media separators,' and 'optical sorters,' come aluminum, zinc, lead and other non-ferrous metals, and clear, amber and green glass chips.

"And there you have it. Most everything of any worth that can be reclaimed from the messy mixture that comes into the plant is sorted and readied for new, productive use. This, in a nutshell, is the story of resource recovery."

"But that's not all we want you to get out of this visit, Mark. We want you," said Tony, "to remember the many careers that went into creating this place. And now I want you to think of the many professions that are needed to keep it operating. Isn't it about time you quit kicking cans and cartons and joined us again?

"Take me, for instance. You know how I always wanted to be a chemical engineer. Well, that's what I am. My staff of chemical technicians and I keep constant watch on the quality of our products. Of course, we recycle the water used in our flotation and washing operations; the quality of that must be monitored, too. There are also health technicians who work here to protect against the threat of contagious disease and to ensure that working conditions and dust levels are safe. In the same way, the state public health employees are needed to test the conditions at our sanitary landfill site and to make sure that the new landfill sites are selected with some consideration of health and environmental consequences.

"Then, too, don't forget about the people who operate our conveyor belts, shredders, separators, balers, and screens. All these machines require much ability and training to operate and to keep in working order. And don't forget that people designed and built all that equipment in the first place. Our plant also employs operators of front-end loaders and forklifts, trash truck drivers and trash handlers, to say nothing of accountants and clerks.

"As you can see, Mark, this whole new industry will need a lot of people with various amounts of training, ranging from as little as a few months for some of the technicians and handlers to as much as seven years beyond high school for a lawyer or a chemist with a Ph.D. But all these people, no matter what their training, are of value to the environmental scheme of things. All of them, from paraprofessionals to college graduates, will be important in saving resources and protecting our environment."

Suddenly, it seemed to Mark that everyone from the old days was watching him. He started to back up.

"All of which is to say, Mark, you should pay attention to us. Do you hear? You're getting drowsy. In fact, you are very tired. Go to sleep! And, when you wake up, you'll remember every last bit of what went on here. Now . . . wake up!" . . .

Morning, and Mark was very late getting up. No time to think about his dream; he'd have to sprint to make it to school. He really hurried, taking the front steps in one jump and loping up the street. He was puffing as he pulled to within sight of Dorita and Tony, Screwball and Ryan going in the school door.

Each of his friends seemed to wear a strange expression. But it was Tony who spoke first: "You certainly must have kicked around a lot of trash to be getting here this late. What's up?"

"That's not it. See, I had this weird dream last night."

"We know. So did all of us."

"You mean?"

"Exactly. We all had a dream about growing up to be on the same soccer team. Even Dorita."

"No," Mark yelled, his voice ricocheting down the corridor. "That wasn't it at all. Wait till I tell you this. Listen . . . '

This story has been about a day in the life of Mark Gamble. But, like many things you read, it really has another story to tell. In this case it is the story of resource recovery—which is a good way by anybody's standards to meet the challenge of solid waste.

Maybe you fit into this picture. Let's hope it's not just a dream.

EPA DOCUMERICA – – James Olive

GETTING INVOLVED IN RESOURCE RECOVERY

What you can do. Now you know the story of Mark Gamble. Of course, it took a lot to open Mark's eyes to what he could do to help in meeting the solid waste challenge. Fortunately, he is only one character. But you also know about Dorita and Tony and Ryan and what they could grow up to do. The point is that everyone fits into this story—even you. And the sooner all of us together start thinking about environmental pollution and resource recovery, the better off we all will be.

Think about it! Naturally, no one could design, or build, or operate a resource recovery facility all by himself. Of course not! But what you can start doing is thinking about the environment, and particularly about the solid waste part of environmental pollution. For just as surely as you're reading this now, you are living through a major change in attitudes toward the environment. Just like the great public concerns of the past, this one is bringing about great changes in people's thinking. Today, people are beginning to object strongly to continued abuse of the earth. People are making efforts to stop their own pollution; they are slowing the pace of pollution on the part of industry and cities; they are rapidly changing the laws of the land to minimize pollution in the future.

If you are to join the citizens involved in making these changes, your first step is simply to start to think. But if just thinking seems too general and vague for your particular brand of action, take the following test to see what you know about pollution in your community.

A little test.

1. Are you alert to the need for a better environment?

2. Are your parents and their friends aware of the solid waste challenge? Have you taken opportunities to talk with them about it?

3. Does your community have pollution control laws for air, water, noise, litter, and solid waste? Are you familiar with these laws?

4. Do you obey the environmental pollution laws? Is your family car or your incinerator a polluter? Do you litter, and do you growl at your friends who do?

5. Is litter prevented from accumulating on streets and in vacant lots in your community? Are there penalties for littering? Are there enough trash containers on street corners and in parks to reduce littering?

6. Does your town have a system for testing for various kinds of pollution?

7. Are all aspects of pollution in your community adequately regulated? Or do you know some form of local environmental pollution that ought to be brought to the attention of your city newspaper, a councilman, or your congressman?

8. Do you support the Environmental Protection Agency's Mission 5000 program to close open dumps?

9. Does your community have a program to collect bundled old newspapers, cardboard, and other waste paper?

10. Is your city considering resource recovery in its solid waste management plans? Are there plans for systems to mechanically reclaim valuable materials and use refuse as a fuel?

If you have answered "No" to four or more of the questions, your answers suggest that your community may have solved waste management problems. But don't worry; there is still time to improve your score. This is not the kind of test you take and forget You have taken it now, but you can keep on improving your score—and your environment—for the rest of your life.

Armed with the answers to these kinds of questions and some well-organized thoughts about the environment, you have an important job to do. Although it's a simple one, it has a number of steps.

First, you should be aware that resource recovery represents a sensible and efficient approach to dealing with the problem of solid waste disposal because it reclaims valuable materials for recycling, reduces the volume of refuse that needs to be disposed of, provides a cheap source of fuel, and operates at the lowest possible cost.

Second, you should share your knowledge of resource recovery and your awareness of environmental problems with friends, responsible city officials, politicians, youth groups, and just about everyone else in your community. Too few people today are aware that a solid waste problem even exists. Although resource recovery may not be the solution to every community's needs, the mere process of thinking about the problem of disposal could in itself lead to more efficient management of solid waste, better disposal equipment, and more sanitary conditions at the community level. Above all, don't underestimate the effect of your own concern because you're "too young." Your awareness may be just the spark needed to bring about a responsible vote for better pollution-control laws. You may never know.

Third, and last, you must act the part of an environmentalist. Whether this involves starting or participating in education campaigns or just not littering is for you to decide. Whatever you decide, however, you will have the satisfaction of knowing that the effort is worthwhile and that the outcome is vital to us all.

Your career. In the long run, your experiences in thinking about and working for the environment may lead you to new frontiers of knowledge and to challenges that could even change your plans for a career. In any case, no matter what you may want to be, you owe it to yourself to make career plans. As you mull over your future, keep in mind the many kinds of occupations that the growing industry of resource recovery will require. Remember that in the future the resource recovery industry must keep pace with all the manufacturing industries if things are to be kept in balance. We know this is true because every product that is made must eventually end up as someone's trash. For this reason, a great many people, doing a great many different jobs, will be required by this new industry.

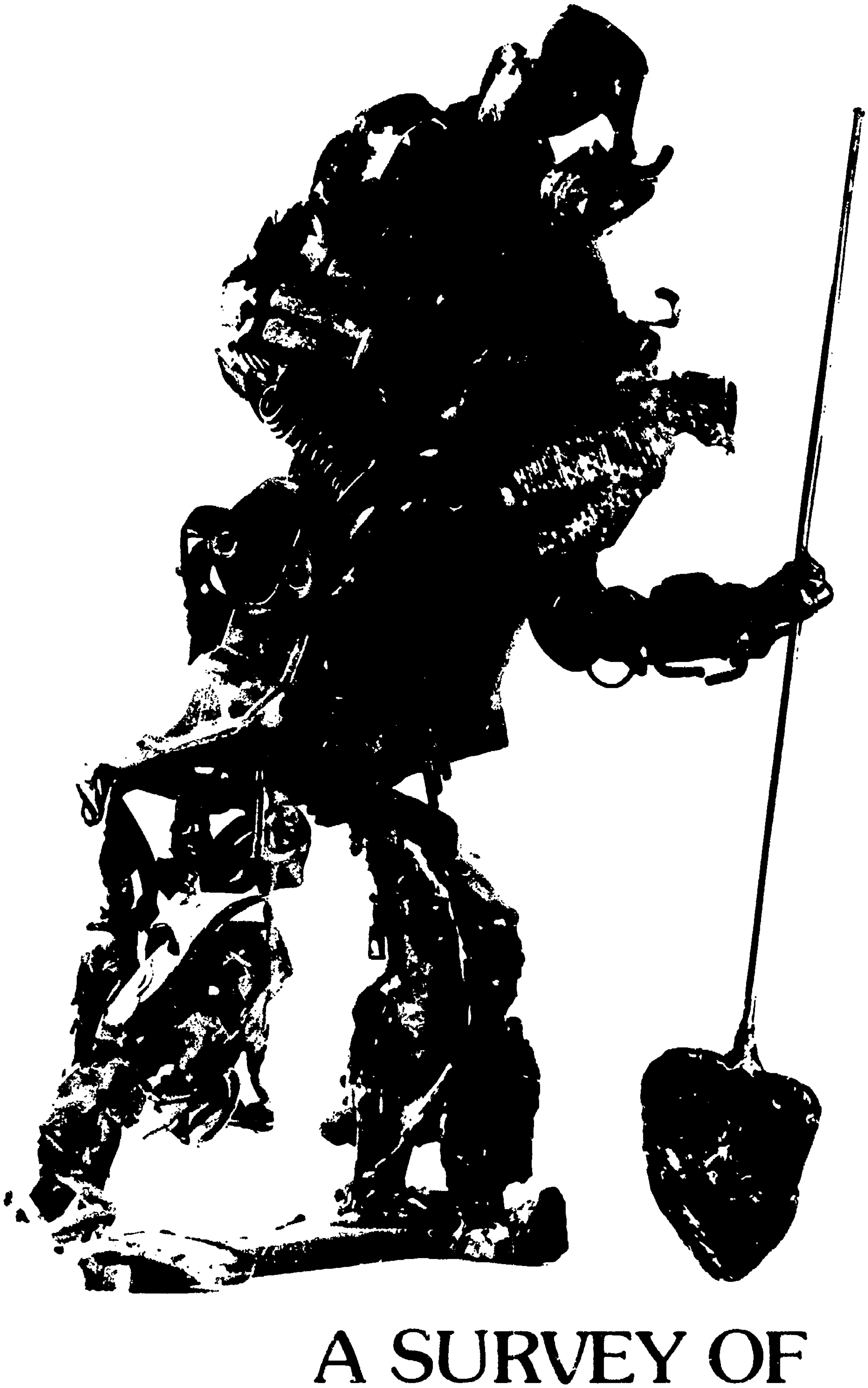
And because it is a new industry, one that is just beginning, it will be making demands for trained people in a way that no existing industry will be able to match. It will be, literally, a new field of opportunity.

The final and perhaps the most telling point to remember is that all the people who choose to work in this new industry—whether they are the highest trained or the least trained, the highest paid or the lowest paid—will be making an important contribution to the quality of life. There are simply too few careers that offer that particular opportunity any more—anywhere.

About our cover statue

"Resourcefully Recovered," a sculpture of junked metals recovered from municipal waste, was made by James C. Berrall for the National Center for Resource Recovery.

BEST COPY AVAILABLE



A SURVEY OF RESOURCE RECOVERY

I. SOLID WASTE: A GROWING PROBLEM

Until a short time ago most of us probably did not think very much about the environment, much less worry about it. Nowadays, it seems we can't turn on the radio or TV or read a newspaper without mention of the subject. Hardly a day passes when some environmental issue in our state or region isn't brought to the public's attention. It is a rare week, too, when our total environment, local environment, or even home environment doesn't come up for debate.

Evidently, *environment* is an extremely serious word, and judging from the number of times and the ways it crops up in conversation, it must also be an enormously complex one. But what does this word mean, and why is everyone suddenly talking about it? Broadly speaking, the word *environment* means "surroundings," and it includes everything in existence.

The environment consists of air, water, and earth—what is sometimes called the *biosphere*. More strictly speaking, all earthly things fall into two basic categories: *organic* (or living) matter, such as people, animals, and plants; and *inorganic* (or nonliving) matter, such as gases, minerals, and liquids. We also speak of our immediate environment, which means all the visible things that are relatively near; we may also think in terms of our broader environment, which refers to things that may be quite far away. Sometimes the terms *microenvironment* and *macroenvironment* are used instead of "immediate" and "broader" environment. Another word in constant use these days—and closely related to *environment*—is the term *ecology*. This is the important branch of science concerned with how people and all other living things relate to their surroundings.

Why have the words *environment* and *ecology* so suddenly burst upon the public consciousness, causing so much debate? Part of the answer has to do with our recent historic flights into space. Now that we have all seen pictures of our planetary home taken by the Apollo astronauts, we have begun to think of ourselves and the earth differently. From space our planet looks small and fragile. We can see ourselves as three and one-half billion astronauts riding together on Spaceship Earth. And we can understand that the resources of this earthcraft are a vital life-support system—the only one we have—a fragile and complex oasis of life in the desert of space.

This awareness has forced us to take a fresh look at our endangered earth home. Everywhere we can see signs of its decay—the blight, the litter, and the far more dangerous threats of air and water pollution. And now another major world environmental problem is growing. It has received much less attention than water and air pollution to date, but we will be taking a close look at it in this booklet. This is the environmental concern of *solid waste*.

A closed system. Our earth is a closed system: virtually nothing enters it or leaves it. The only life-maintaining things we have on our planet are those contained in a thin layer of air, soil, and water. These life-giving elements can be converted into products and energy. Matter is never used up; it is simply converted into other forms. At the same time, all living things are interrelated, each depending on things beyond itself. For example, consider air and two of its vital ingredients, oxygen and carbon dioxide. When human beings and animals breathe in, they take in oxygen; when they breathe out, they exhale carbon dioxide. Green plants, however, take in carbon dioxide and produce oxygen. Thus, there is a two-way relationship between people and plants—an example of interdependence.

How do changes in the environment affect us? Every day countless things happen in our environment that have either a good or a bad effect on us. Lightning strikes a tree, rain falls on a field, an early spring frost kills flowering crops, a flood causes erosion along a river, animals are born, birds migrate—these and many other natural changes in our environment happen all the time, following nature's rhythms, cycles, and biological clocks without the action of man.

Sometimes these earthly changes are swift and violent. A volcano may erupt or a tornado may strike. These natural disasters may injure people.

but they do not affect the natural patterns and cycles we all depend on for life. If left to itself. nature usually deals with its own residues, changing them over time into new and usable forms.

Many changes in the environment are man-made. Like natural changes, they can be helpful or dangerous. We may cut down trees and pave an area of grass and flowers, but we can also make an entire desert bloom. We may thoughtlessly dump wastes into the world's rivers and lakes, but we can also purify water that is unsafe to drink. We may hunt an animal species to the point of extinction, but we also have the ability to protect and improve a breed of livestock. More than any other creature by far, human beings have the choice of making both helpful and harmful changes in their environment.

Problems begin when the fragile balances of nature are seriously disturbed and made difficult to restore. Most wastes that are created naturally, such as decaying leaves, are not in themselves harmful. But man-made wastes can become *pollution*, an overload of refuse that critically upsets the natural systems of the environment. Until now, air pollution and water pollution have attracted the most attention, but this is beginning to change. Solid waste—"the third pollution"—is now being recognized as a major problem.

As a nation, and perhaps as a world, we have mistakenly assumed that nature's self-cleaning powers would magically take care of man-made trash and garbage. But there are limits to how much waste the air and water can absorb. The past few years have taught us that even the vast systems of nature have a saturation point. We are finally beginning to understand that our poor management of refuse threatens air, water, and soil; destroys important resources; and makes the collecting, processing, and disposal of our growing waste more expensive.

There are positive approaches to changing our daily discards into valuable resources for further use. But before we discuss these methods, let's look more closely at some of the history behind this very old and long-neglected problem of the "third pollution."

Solid waste: an old problem. As archaeologists well know, the problem of solid waste disposal has been with us for a long, long time and has increased with the growth of civilization. Ancient peoples who lived in caves or huts simply piled their discarded bones, shells, and broken pottery into heaps. When the heaps grew too large for their caves or small communities, the people moved on.

When people began to build cities, waste disposal became more of a problem; for example, when the site of the ancient city of Troy was excavated in the late 1800's, archaeologists found other cities buried beneath it, going back to 3000 B.C. As each city died or was destroyed by war, its solid wastes soon became the foundation of the new city built on top of it.

The change in economies from agriculture to industrial has also had a serious effect on the problem of disposal. When our country's economy was based on agriculture, people fed their food wastes to livestock and plowed animal wastes back into the fields. Because metal, clay, and glass containers were scarce and expensive, they were treasured and handed down as family heirlooms. People burned paper as fuel in their stoves and fireplaces. In the villages and towns, ragpickers and junkmen made a living by picking up and reselling leftover items for reuse. As towns grew, their citizens decided to pay more taxes in order to have extra trash picked up and hauled away somewhere. But the problem still wasn't severe.

With the start of the Industrial Revolution in the 19th century, the population increased rapidly. More and more people began to live in cities. Many people were finding that they could afford a higher standard of living, with many new products to make life pleasanter and more convenient. But while these changes were going on, the methods of waste disposal stayed much the same. Even today, many Americans still dispose of their trash and garbage much as the prehistoric mammoth-hunters did—by burning it or tossing it aside. The major difference is in the amount and kind of waste.

Where once the world's population may have numbered only a few million, it is now in the billions. In ancient times it took many generations for a family of hunters to fill a cave with litter. Today an American family throws away on the average about 7000 pounds of solid waste a yea[r]. Another important change is in the nature of wha[t] is thrown away. The materials our ancestors used were natural ones—rock and wood, bone and antler, hide and sinew. The mountains and forests seemed limitless. New births filled out the animal herds each year. Gathering food took most of people's time. Food production now takes a much smaller part of our labor. Food wastes are only 10 to 14 percent of family refuse. Almost all the rest consists of products from our shrinking supplies of natural resources.

The most favorable explanation of this trend would be to say that we have been too busy raising our standard of living and making more products faster to notice the growing piles of waste we have been creating. But one thing has always been certain: we can put solid waste out of sight and even out of mind, but in the end we have to put it somewhere. Today many towns and cities have no space left to bury waste or pile it up. As one city official glumly remarked, "Everyone wants garbage picked up, but nobody wants to let us put it down."

Today collecting and disposing of solid waste in American communities are major expenses. Their share of town and city budgets is sometimes next to those of schools and highways in size. Yet in spite of these high costs, the national trash pile is still growing.

The price of progress. What factors have led to the increase in solid waste? There are many, but three of the key ones are a growing number of people, a great increase in the number of products made and used, and the often inefficient ways in which solid waste is handled. Just looking at population growth alone, we can see how these factors work together to create many problems.

In 1917, after three centuries of growth, America's population passed 100 million. Now, half a century later, our population has doubled to more than 200 million. If the present rate of growth keeps up, by the year 2000 the figure for 1917 could even triple, with 300 million people living in our country. Even if our population grows at the rate of 1 percent per year, our use of electrical energy and our production of wastes will grow at several times that rate! And at our present rate of consumption, although Americans make up less than 10 percent of the world's population, we are using up 40 percent of the world's goods and services!

Our "waste load" has been growing in part because of our demands as consumers for safer and more convenient ways of doing things. In the past half century thousands of new products, from food containers to artificial heart valves, have helped to create a whole new world of service, convenience, safety, and enjoyment. These products are used in so many ways and in so many different forms that we sometimes forget that they have become available only relatively recently. But the use of these new products means more manufacturing plants, more complex machinery, and more energy needed to run the machinery.

The increase in our population and in our rate of consumption has serious implications for our supply of natural resources and raw materials. If we do not do more to conserve and reuse them, there is a real danger that some of them will be in short supply by the end of the century. Some resources, such as forests, can be replanted. But resources like oil and some minerals can be removed from the earth until there are none left, at least in the original form. And even if our resources were unlimited, we would still have to worry about disposing of our growing accumulations of trash and garbage.

Protecting the environment and conserving our resources are problems that do not have easy solutions. There is probably no single "best" answer or "complete" answer. Some attempts at solving the problem may even create other problems. Nevertheless, there are things that can be done. The same technology that has helped to create our high standard of living can also help in solving the waste problem. What we need to do is to harness the waste explosion and make it work for us.

What is solid waste? Waste is almost anything that a person considers worthless and throws away. For the most part, this unwanted stuff falls into four classes: agricultural (plant and animal) wastes, mineral (primarily mining) wastes, industrial wastes, and municipal (town and city) wastes.

All told, Americans produce some 4 billion tons of solid waste per year. Agricultural wastes account for about 2.5 billion tons; mineral wastes for more than 1 billion tons; nonrecycled industrial wastes for nearly 130 million tons; and household, commercial, and other municipal wastes for about 125 million tons. Each person in America now discards an average of 5.3 pounds of household refuse every day, or nearly a ton a year! The waste we as a nation produce in one year now is enough to cover the entire state of Connecticut with a layer of trash and garbage six inches deep! Every year we discard 30 million tons of paper, 2.5 million tons of plastics, 65 billion cans, 38 billion bottles, 8 million television sets, and 200 million tires. Unless something changes, by the end of the century America's refuse will be double what it is today.

Municipal waste. Of the four major kinds of waste, municipal refuse is the smallest amount by weight—less than 3 percent of the nation's solid waste. However, it presents the most immediate and obvious problem. Municipal trash and garbage are produced in the towns and cities where people live, and they have to be disposed of within a limited area.

Municipal waste is made up of the things thrown away from households, offices, schools, and hospitals. It includes the things we ourselves toss away— on vacations, in school, and at home in our trash and garbage cans. Usually, this kind of waste is collected by door-to-door trashmen who haul it away to open dumps, landfills, and incinerators.

Although anything from an old hamster cage to great-uncle's ukulele qualifies as municipal refuse, household trash baskets and bags more often hold such leftovers as food scraps, pieces of broken glass and pottery, grass and leaves, worn-out leather goods, metal objects, pieces of wood, wastepaper and newspapers, plastics, rubber goods, stones, worn-out clothing, and just plain dust and dirt.

Actually, the word *garbage*—which most people think of as everything that goes into a "garbage" can, "garbage" truck, or "garbage" dump—refers only to the food waste portion of refuse. Much of it comes from restaurants, hotels, supermarkets, and other places where large amounts of food are prepared and where food scraps are discarded. This type of waste contains up to 70 percent moisture. The term *trash*, or *rubbish*, on the other hand, refers mainly to dry waste materials—paper, rags, bottles, cans, etc.—from households, offices, and institutions. The convenient, all-purpose term for both types of waste—garbage and trash—is *refuse*, which refers to any combined solid waste.

Another important kind of distinction concerning waste is the one between *organic* and *inorganic* solid waste. Organic waste comes from living things. The substances contained in it, which are chemically different from inorganic substances, are made up of carbon atoms in combination with atoms of some other elements and are generally produced in the life processes of plants and animals. Food wastes fall into this category, as well as paper (from trees), wood, plastic (from oil and other natural resources), rubber, and yard clippings. Inorganic waste, by contrast, is made of matter other than plant, animal, and certain chemical compounds of carbon. Examples of this group are metals and glass.

Litter. Another type of waste, and one that is a nuisance, is *litter*. By definition, litter is whatever is thrown away in the wrong place—an old tire thrown into a brook, a tin can discarded at the side of the road, an apple core or a candy wrapper tossed on the sidewalk. All these kinds of litter are caused by people; thus litter is the one refuse problem that everyone can help to solve.

At present our solid waste is handled within some system: every community has some kind of process, no matter how old or inefficient, for coping with its refuse. But litter is beyond the reach of any present system. It is the visible part of our total refuse, like the tip of an iceberg.

Besides causing the same problems as other kinds of refuse, litter has certain particularly bad effects. It discourages tourism, lowers property values, drives away shops and businesses, and—by causing ugliness—makes every one of us a little poorer. It hurts our pocketbooks, our eyes, our health, and our safety. Yet, all the litter that defaces our cities and spoils our countryside could be changed into rich resources to be reused over and over again.

How can we begin to cope with the problem of litter? First of all, we must work to change basic attitudes so that people who litter are made to feel guilty, with the result that being caught in such behavior will be too embarrassing. Since 1953 the national antilitter organization *Keep America Beautiful, Inc.* (KAB) has worked to change public attitudes concerning litter. It has tried to make people aware of the problem and to suggest possible solutions—new antilitter laws, intensive educational campaigns, more public trash containers, and such new machines as street vacuum cleaners to remove litter.

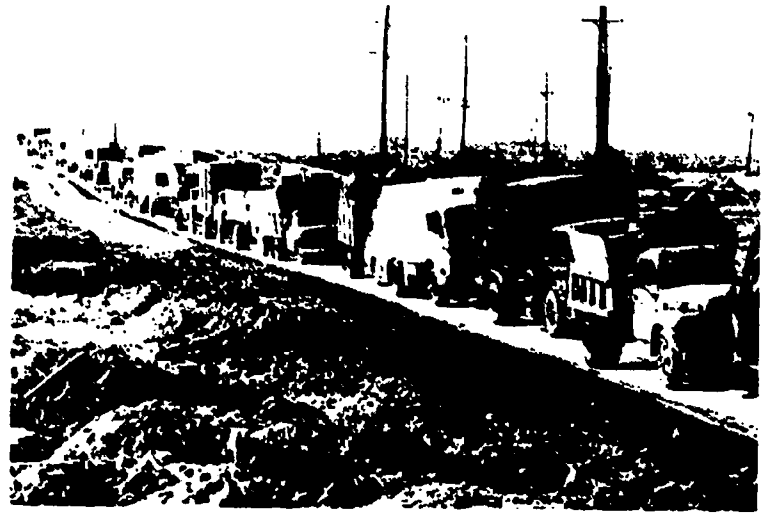
Most experts have long believed that solving the litter problem will be much more difficult than solving problems concerning other solid waste. Research is being done to find out why and under what circumstances people litter. If more is known about why people behave so destructively toward their environment, perhaps better ways can be found to solve the litter problem.

What can we do about solid waste? It is a fact that nearly every human activity produces some waste or discard. But solid waste is bad only as long as it is badly managed: then what goes into the air and the water and onto the land comes back to confront us as environmental blight. Solid waste is also bad when it is allowed to grow while our supply of natural resources shrinks.

There seems to be growing agreement that the most promising method of dealing with waste is resource recovery. Refuse is rich in materials that can be saved and reutilized for new products. This idea of recovering resources from solid waste is gaining support. It helps both to reduce pollution and to save natural resources— a twofold benefit for the environment. One United States Senate committee recently summed up this view by saying that unless we want this planet to turn into a "polluted trash heap," we must stop discarding so much trash and begin to reuse everything we can.

Obviously, we cannot allow our planet to become congested with trash. Let's take a closer look at the problems involved in three stages of solid waste management— collecting and transporting waste, disposing of waste, and recovering resources from waste.

II. COLLECTION AND TRANSPORTATION



Each year our towns and cities spend about $5 billion to collect and dispose of trash and garbage. Between 75 and 80 percent of this cost goes for the collecting and trucking of refuse. That leaves less than 25 percent to spend on a much more serious problem—disposing of the trash and garbage once it has been collected.

The amount of refuse collected from homes, offices, and other buildings throughout our country is about 125 million tons a year. Refuse collection is a particularly difficult problem in large cities. Try to imagine, for instance, how much trash and garbage comes from New York City's Trade Center, whose twin towers can hold 130,000 workers and visitors! In 1974 this city-within-a-city will produce about 50 tons of trash a day—the take-off weight of a giant Boeing 747 jumbo jet. And that's just *one* big skyscraper complex!

Today both huge cities and small towns are in great need of more efficient trash removal services. We still see the same slow, inefficient, and expensive methods that have been used for the last 50 years. Noisy, smelly garbage trucks and trash trucks crawl up and down busy streets, tying up traffic. Behind the truck jog one or two helpers, who pick up trash cans and empty them into the truck. Then the trash is hauled away, out of sight. In many cities, uncollected or poorly stored trash and garbage breed rats, flies, and other disease carriers.

Technology has made some improvements in the process of collection. Refuse trucks not only collect but also compact trash, thus carrying it in less space. Even so, the amount of waste has increased so much that more trucks are needed, as well as more men to drive and load the trucks. The result is that collection costs have also continued to increase.

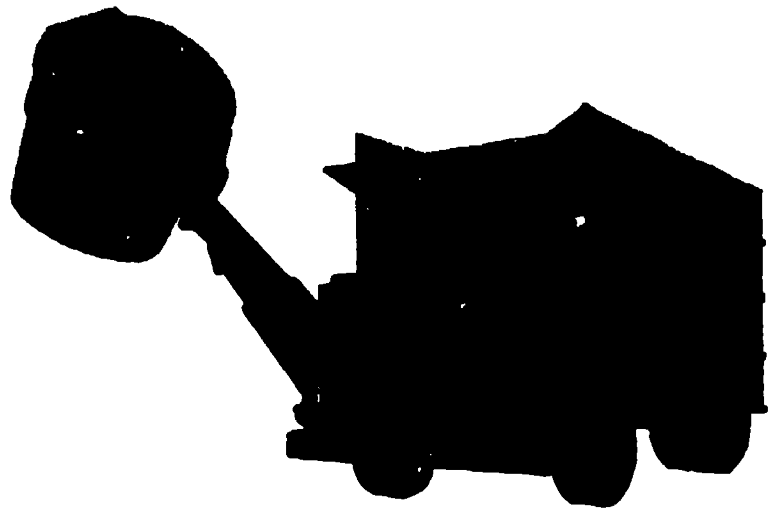
Another problem is that trucks must sometimes carry refuse long distances to the point of disposal. Transportation was a minor problem when cities were smaller and dumps, incinerators, and landfill sites were within city boundaries. But the growth of cities and their surrounding suburbs has pushed disposal sites farther away. San Francisco, for example, now takes its refuse to a landfill site 30 miles beyond its city limits.

Why haven't we been able to apply new ideas and methods to our refuse problems? Technology has made some improvements, but compared with progress in other areas, major changes in refuse collection and transportation remain to be made. There are three main reasons why so much money and energy are devoted to just getting the job done and very little of either is devoted to improving the whole system. First, labor is the biggest cost in collecting waste, since wages are going up all the time. And, it is getting harder to find workers willing and able to collect trash. Second, collection equipment costs a lot to buy and keep up. Third, there are high illness and accident rates among workers. It is not generally known that trash collection is one of the most dangerous jobs in America today—nine times more dangerous than the average industrial job.

Perhaps the greatest hindrance to improving waste collection is public apathy. The problem of removing solid waste does not cause the same excitement and drama as an oil spill or a smog crisis. As a result most cities and towns have not yet begun to use many of the modern collection methods that are available. But collection is a basic part of the solid waste system and the part that affects people most directly. No matter how completely and efficiently solid waste can be reclaimed and recycled, it will still have to be collected first. And although waste disposal is a much greater problem in terms of pollution, collection remains the greater problem financially.

Modern technology can be applied to solving the problems of solid waste if the money needed is available. In the long run, new methods will actually save money for communities by reducing the cost of collection; it is possible to reduce the cost of collection and at the same time to improve collection methods. For many communities, where to begin is the problem.

New collection systems. In recent years many improvements have been made in waste collection and disposal. Some of these methods have been developed in other countries, where they have been used more in single communities than on a nationwide scale. In our own country some progress has been made through such modest inventions as garbage disposals and low-priced garbage bags. A garbage disposal can shred and wash away the smelliest and messiest 10 percent of household refuse. Light plastic bags make refuse handling cleaner and easier than the old process of emptying refuse from bent and battered metal cans. Electric wastebaskets cut up office paper to reduce bulk, and small home compactors compress refuse to less than a fifth of its original bulk, while neatly wrapping it up for final disposal.



Of greater long-term significance are the new inventions and systems now in use or in the process of development. One city's answer to the collection problem was to eliminate the need for workers to run to and from houses to the waiting collection truck. The desert city of Scottsdale, Arizona, with help and funds from the Environmental Protection Agency (EPA), defined its collection needs and had the machines designed to meet them. The result was a highly automated collection truck, called the "Son of Godzilla," operated by one man. This machine has a mechanically controlled arm that picks up refuse that has been set at the curb. This eight-foot arm can grab, lift, dump, and replace a specially designed garbage can in less than 20 seconds.

The Scottsdale experiment is working well. Nearly all the residents involved in the trial test like the system. Scottsdale officials expect that it will reduce collection costs by about $75,000 a year. Meanwhile, the workers who drive the new trucks enjoy air conditioning and stereo tapes as they make their rounds.

Other kinds of truck equipment have made collection more efficient. Among these devices are side-loaders and shredders which can reduce garbage to one-tenth of its original volume.

Walt Disney World in Florida uses vacuum tubes to take in trash and whisk it away. These tubes are part of an advanced method developed in Sweden and called the Automated Collection System, in which refuse travels through large underground vacuum tubes. In some ways these tubes are like the small tubes that are sometimes used to carry sales slips and money in department stores. These giant tubes can also be connected to apartment buildings, hospitals, or offices. Once or twice a day the user simply drops his trash into a chute. There it waits on top of a steel valve, which from time to time slides open and sucks whatever is resting on it into the tube. The trash is swept away at an extremely high speed to a central collection place or incinerator.

At Walt Disney World, while visitors above chat with Mickey Mouse, unsightly and unseen trash travels about 30 miles an hour through underground pipes. It goes to a depository located far from the busy recreation area. There it is compacted into bales and then hauled to a new incinerator capable of handling 50 tons of waste per day.

Community officials across the country are taking a close look at this underground experiment. Whether it is called the "pipeline system," "the vacuum system," or the "pneumatic (tube) system," this method is one of the most exciting new developments in waste collection.

The transfer station is another relatively new development in the collection process. It attempts to solve the problem, following collection, of getting refuse moved to a disposal site as fast and as cheaply as possible. This has not always been the problem it is today. Since in the past the amount of solid waste being handled was not so great as it is now, the same truck that collected waste could also drive it to the dump, incinerator, or landfill. Disposal points are being located farther and farther away from the cities and communities where the wastes are collected. At the same time, transportation costs are increasing steadily. Because it is no longer practical for the collection truck to haul waste a long distance to a disposal point, new and more efficient systems are needed.

At transfer stations the waste is moved from the collection trucks to much larger vehicles that carry it to the final disposal facility. Some of these vehicles have powerful machinery for compacting the refuse. Mor· ·ften the waste is transferred to a building where · ·s compacted; it is then loaded into tractor trailers or even trains for the final trip to the disposal site.

Several cities have shown an interest in developing transfer systems with machines that separate different materials for recycling. In San Francisco, Golden Gate and the Sunset Scavenger Companies have taken on the job of processing all the city's refuse through a modern transfer station. From there, the solid waste is taken to a sanitary landfill in mountain views that will eventually be made into a landscaped golf course and recreation center. This operation has handled large amounts of waste so efficiently that the idea is being extended. Plans are now being developed for sorting out metal and glass for recycling at the transfer station. A number of other methods for cutting collection costs are being investigated. Cities and towns served by railroads can have compacted wastes hauled many miles to sanitary landfills at lower costs because of the volume of business for the railroads. Towns and metropolitan centers located on waterways have for many years used barges to transport refuse to disposal sites. In London and New York, for example, barges float under a transfer station to be loaded from above. This system has been found to be slightly less expensive than hauling by rail.

Of the many new ideas for collection, more promising seem to be the automated collection truck, the vacuum tube system, and the use of transfer stations. By putting new machines and methods to work at the community level, we can help to free money and energy for more difficult and more demanding problems in solid waste management, such as improving waste disposal.

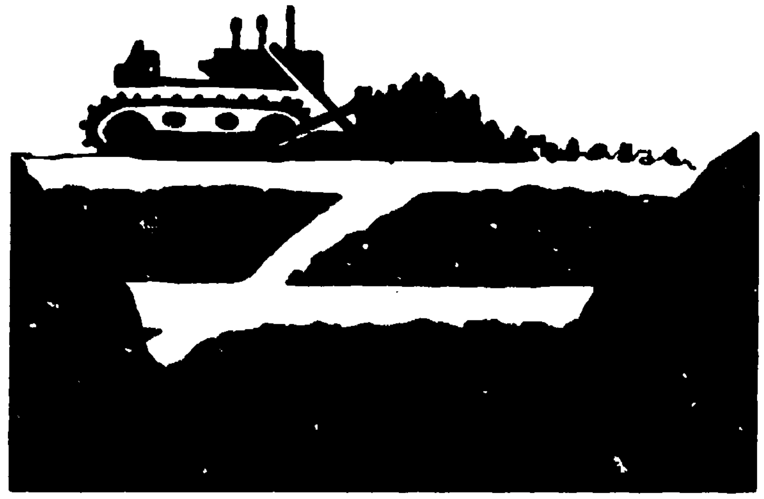
III. DISPOSAL

What happens to our refuse, once it is collected and hauled off? Believe it or not, in an age when we have the know-how to land men on the moon and to send rockets into space, most city trash is simply deposited, month after month, in open dumps where it either rots or burns. This method is only a slight improvement over those of ancient times. The piles of trash and garbage in such open dumps often pose a fire hazard, cause air and water pollution, and provide a breeding ground for rats, flies, and other disease-carrying pests. Although open dumps seem to be the least expensive disposal method, they are perhaps the most expensive environmentally, since valuable resources are wasted.

The practice of open dumping has been outlawed almost everywhere. Nonetheless, almost 80 percent of municipal solid waste still goes to open dumps. Laws passed against open dumping are not of much help unless the laws are strictly enforced and realistic alternatives are provided.

Today even the poorest communities are beginning to realize that open dumps are no longer an adequate method for disposal. For one thing the amount of solid waste is growing rapidly, and for another, less land is available for waste disposal. We must develop a disposal system that will replace open dumping.

Some national organizations have conducted successful campaigns against open dumping to spur the development of environmentally safe, nonpolluting methods of waste disposal. The Environmental Protection Agency, for instance, launched a program called *Mission 5000* in the summer of 1970 to close the nation's dumps. So far this very successful program, with the cooperation of various levels of government and the understanding and support of the citizens and communities involved, has closed over 2000 dumps, and hundreds of others are scheduled for early replacement.



Alternative methods of disposal. As people have become more and more aware of the disadvantages of unsanitary open dumps, there has been a move toward a safer and far more effective method of waste disposal, the sanitary landfill. In this method, each day's refuse is placed in a trench or depression at the landfill site. It is spread, compacted, and then covered with up to a foot of soil at the end of each day or several times a day. Landfills take advantage of the fact that many soils have a tremendous capacity for absorbing and neutralizing polluting substances. In the soil organic wastes are broken down naturally into compounds that reenter the natural cycle of plant and animal life. Soil also acts as a filter for many inorganic chemicals.

Sanitary landfills have many advantages over open dumping and burning. Covering refuse with soil prevents open fires and odors, discourages vermin, and keeps litter from blowing away from the site. When properly located, designed, and managed, a landfill is clean and attractive. The site can later be used for parks, playgrounds, golf courses, or even airports and housing areas with no trace of the refuse deposited underground.

Landfills can be used to create hills as well as to fill low areas. Household refuse has been used that way in several "Mount Trashmores" that have sprung up across the country. For example, Virginia Beach, Virginia, after five years of stacking 400,000 tons of refuse at the same site, has created one of the largest and best known of the "Mount Trashmores." Eventually, this site will contain a picnic area, a coasting ramp for soap box derbies, and a 10,000-seat amphitheater.

Landfills, however, also have some disadvantages. Near most cities suitable land is hard to find and often prohibitively expensive. As more distant landfill sites are found, transportation costs tend to become too high. Another drawback of landfills, as of open dumps, is that valuable resources are buried.

A third major method of disposing of municipal solid waste is to burn it by means of incineration. This process consumes refuse within an enclosure, from a small backyard pit or metal basket to a huge 1600-tons-a-day installation like the one in Chicago. Municipal incinerators today handle less than 10 percent of all municipal refuse. But incinerators, like sanitary landfills, will gain in popularity as the practice of open dumping declines. Because more than half of municipal waste is organic (paper, wood, and textiles), incinerators are able to reduce the volume of burnable refuse to a fraction of the original—as much as 85 percent reduction in volume and a 60 percent reduction in weight. Thus, the amount of the remaining refuse that must be transported to a final disposal point is greatly reduced. With a smaller volume of waste to bury at a landfill site, the life of the landfill is greatly extended.

Incineration also has other advantages as a method of waste disposal. Since even large incinerators do not require much room, they can be centrally located in the city. The new incinerators, which are also designed to serve as sources of power, are almost pollution-free. Unfortunately, according to a recent study by the Environmental Protection Agency, at least 75 percent of the nation's large-city incinerators are older units that are substandard and fail to keep the air clean. These older models often release unburned particles and poisonous gases into the atmosphere. And, like open dumps and landfills, outmoded incinerators waste valuable resources.

There are, however, ways of making incinerators efficient and environmentally acceptable. Devices can be installed in the smokestacks to trap both unburned particles and polluting gases. In some of the newer incineration processes, for example, electrically charged plates or pipes called *electrostatic precipitators* collect or separate out dust particles that would otherwise pollute the air. Several very successful incinerators also contain devices called *wet scrubbers* that catch dust particles and gases by spraying the exhaust with a liquid, usually water, or by forcing the air through a series of baths. Both methods are less expensive and more efficient when built into new systems than when put into older incinerators. But building new incinerators costs a great deal—often several million dollars. For that reason not many incinerators with these antipollution devices have been built.

Comparison of various disposal methods. Open dumping, which sometimes seems like the easiest solution to the disposal problem, is really no solution at all. Unfortunately, most of the solid waste collected in American towns and cities ends up in open dumps. As this waste rots and burns, it pollutes the air and water and offers a fertile breeding ground for disease-carrying pests. Compacting refuse for burying in a sanitary landfill and burning refuse in a nonpolluting incinerator are better methods. When properly carried out, these operations dispose of solid waste without environmental side effects. And since there will always be some residue, sanitary landfills will continue to be needed.

Although developing better methods of waste disposal is progress, it does not provide a complete solution. We must have better methods of disposal than merely getting rid of waste without causing pollution or public health problems. Waste disposal is closely related to another major problem facing our nation—a growing shortage of natural resources. With many of our forests gone and our minerals depleted, we cannot afford to burn or bury materials that can be saved and reused. A total solution to the solid waste problem must include not only pollution-free disposal but also recovery of all the materials and energy values possible.

IV. RESOURCE RECOVERY

Until now we have been looking at ways to collect and dispose of solid waste. But dealing with solid waste presents a unique p. sibility—that of resource recovery. How can trash and garbage be made useful? There are no easy or magic ways to change them into new products for us to use. But we know that they contain valuable resources—paper, metals, glass, plastics, rubber, and organic materials. Many of these materials can be processed for reuse. Now you can see why scientists, environmental experts, government officials, and other concerned groups are thinking more and more about resource recovery— reusing and recycling refuse— as a long-term solution to the problem of waste disposal. Resource recovery has many advantages: it is nonpolluting, it will save money through the sale of recovered materials, and it will serve as a source of fuel instead of burying or burning them.

Closing the circle. We need to become more aware of the great need to conserve and reuse every available resource, whether in the form of raw materials or of solid waste. And we need to develop more efficient recycling systems. The concept of resource recovery actually copies the pattern of recycling found in nature, where all matter is combined, broken down, and recombined in a never-ending process. We can learn to work with this process instead of against it by applying the recycling principles of nature to solid waste. But how can we do these things? Let's look at the way resources are made into products.

In the past we have obtained resources from nature by harvesting, slaughtering, mining, and collecting. Once the resources have been obtained, they are processed (as iron ore in a steel mill), packaged (as sheet metal by a can maker), sold (as cans of food in a supermarket), and used (by consumers). Whatever is left over, such as used containers, is discarded. In resource recovery we are seeking a process for reusing discarded materials. This process, which might be called "closing the circle," is illustrated in the resource recovery loop shown on page 20.

Resource recovery—past and present. Resource recovery is not a new idea, although the need for doing it is becoming more urgent. Actually, in some kinds of conservation, previous generations may have been ahead of us. In earlier times it was practical and even necessary for families to be involved in recovery at home. A family's garbage was fed to animals. String and paper were saved to wrap yet another package. Clothes were kept and used until they wore out. Old blankets were braided into rugs. People went to nearby stores with the same pail or pitcher to be refilled many times. And the town ragpicker made sure that still other things were used again.

The growth of industry added to resource recovery at home. Bottles to be returned to industry by individual users were either washed and reused or melted down and made into something new. When supplies of tin and paper were becoming scarce in World War II, householders enthusiastically separated newspapers and cans from their regular trash so that these products could be reused or recycled.

Since World War II, the trend in most places has been not to bother with segregating waste; it has seemed much easier to throw waste away than to try to recover it. Separating refuse by hand takes time and is sometimes hard to reconcile with the pressures of modern living and our demands for convenient, efficient ways of doing things.

If individuals and families are not willing to do much about resource recovery, perhaps communities can. Municipal recovery, like household recovery, is not entirely new. Back in 1902 a man named Albert C. Day addressed himself to what was then still "the garbage question," announcing that "the fortunes of the future will be made from the crumbs that fall from the world's table." This statement was published in a booklet promoting his own company, The United States Garbage Reduction Co. Mr. Day's vision was clear, but his resources were scant. He planned to search out scraps of leather and convert them into a manufactured substance that could be used for shoes and belts. The remaining trash would be sorted for bottles and pans. But hand picking was then the only available method of resource recovery.

In 1916, the city of Cleveland started a slightly more mechanized recovery operation. Refuse was piled on a revolving belt, and workers pulled from the pile what was useful. One man pulled out better grades of paper, a second man pulled out rags, and a third man salvaged tin cans. Although the plant was not very successful, it proved the basic theory that recovering resources could be profitable. But it was only by working long hours at low wages that the men could salvage enough to make the system pay. When wages began to go up, resource recovery by hand sorting declined because it cost more to separate the materials than the materials were worth.

In recent years there has been a dramatic increase in public interest in preserving our natural resources. One important way to do this is by recycling refuse. Local collection and recycling centers have been springing up around the country as a voluntary method of resource recovery. In almost every state people can bring their paper, metal, and glass to recycling stations for collection and processing. Here volunteers, young and old alike, sort and separate trash in order to save reusable materials. These materials are often sold back to the industries that manufactured the containers or products in the first place.

Although the idea of extracting resources from municipal trash and garbage is relatively new, industrial recovery has been going on for years. Industry has recycled its own solid waste as salvaged, or secondary, materials. More than half the material used in manufacturing steel and lead comes from scrap. The manufacture of paper, copper, and brass uses a little less than half of scrap material; of aluminum, just less than 20 percent; and of glass, 15 percent. Most of this secondary material is produced and reused within the industrial system. Sometimes the scrap is thrown right back into the industrial hopper, usually to be melted down and go through the manufacturing process again. More often these materials are salvaged by dealers, processed for reuse, and sold back to the original manufacturer. The scrap-processing industry, with over 700 professional scrap dealers across the country, depends on getting industrial discards unmixed with other materials. These preseparated materials are relatively easy to recycle, in contrast to recovering materials from municipal refuse — which is the major recycling challenge today.

Despite the enthusiasm for community recycling drives, difficult practical problems remain to be solved. For example, important as voluntary campaigns have been, they are not the best final answer because they still depend mostly on hand sorting. The new systems now in development will use mechanical systems to efficiently separate all reusable materials from mixed garbage and trash.

Putting waste to work. In the 1960's and 1970's America has moved into a new era—the Space Age. Our success in putting human beings on the moon showed us that when we wanted to and needed to, we could devise machines and methods to accomplish almost any technological goal.

Today, with new technology at our command, we are taking another look at the problems of solid waste and resource recovery. The increasing cost of solid waste disposal means that it may be less expensive for some cities to process their waste and to reuse materials from it than to simply dispose of the refuse. One reason for this is higher costs to handle waste and a shortage of space for landfills. Another reason is that many of the earth's materials are in limited supply and the solid waste stream provides a treasure trove of materials and energy that should be preserved. With the knowledge and technology that we now have, we are capable of recovering greater amounts of these resources than we are now doing.

For resource recovery to succeed, we need to consider making use of materials in several different ways. We can:

1. *recycle* material (such as glass for new bottles or scrap metal for new metals) to return it to its original use or a similar use;
2. *reuse* scrap or recovered material as raw material for an entirely new material, such as glass for the road-paving material called "glasphalt," paper fiber for roofing asphalt, and rubber tires for artificial reefs;
3. *convert* waste materials into energy by using organic food, plastic, or paper-waste refuse as fuel; or into new materials through such processes as composting and pyrolysis.

Things worth saving. The greatest challenge in waste management comes after refuse has been collected at a central location and is ready to be recovered. The purpose of resource recovery is to regain as many valuable resources as possible and then to reduce what is left over to the smallest dimensions for final disposal. Resource recovery may seem complicated, but it is already working, and a few forward-looking communities are already seeing results.

What would an ideal resource recovery operation be like? The process of recovering and recycling municipal solid waste involves two main kinds of materials—inorganic, the portion of waste composed of metal and glass; and the organic portion, composed of food, plastics, rubber, plant material, etc. The first step in a complete resource recovery system is the delivery of mixed waste by truck to a city reclamation plant. There, in a series of mechanical steps, the sorting operation begins.

In our ideal plant a city's mixed refuse is carried on a conveyor belt to a shredding machine. This machine grinds and shreds the refuse into pieces of about the same size. The next step sorts the pieces by weight. The shredded refuse then enters an air classifier or blower. In that process the heavy (inorganic) pieces—metals and glass—drop to the bottom while the lighter (organic) pieces—food waste, paper, plastics, and wood—are blown out an upward chute for disposal or more processing.

The heavy pieces that remain pass through a *magnetic* separator that pulls out iron and steel for sale and recycling. Nonmagnetic materials—aluminum and glass, in particular—are then further separated. Electric eyes are used to sort a stream of glass according to color: color differences in the stream trigger air jets that blow clear and colored glass into separate bins. At the same time, tanks of liquid are used to separate nonferrous metals—especially aluminum—by how well they float. This process is known as flotation.

Materials Recovery. If you think that this ideal separating system is one that only a city of a million or more people can afford, consider what Franklin, Ohio—a community of just 10,000 people—is already doing. Until recently, the town of Franklin buried its daily trash layer on layer in a nearby sanitary landfill. When the landfill was practically full, the citizens of Franklin took a bold new step toward a permanent solid waste solution by building a unique recycling system.

Funded partly by a grant from the Environmental Protection Agency, the Franklin plant uses machinery originally designed for recycling wastepaper. But the process now handles all the town's daily output of 50 tons of refuse, and it can handle much more in the future. The metals recovered in this plant are bought and reused by a nearby steel company. Reclaimed paper fiber is sold to another local company to make roofing felt. Glass is also recovered to be sold. In a final step a modern nonpolluting incinerator takes care of whatever cannot be recycled. Only 2 percent of the original refuse volume remains for disposal.

But what about all the valuable refuse we continue to throw away without any attempt to recover its resources? Each year hundreds of city incinerators dispose of thousands of tons of mixed garbage and trash. In almost every case the residue, or what is left of the refuse after incineration, is uselessly buried—and buried "alive"— because even after burning, the residue can resupply many valuable resources. The "urban ore" present in incinerator residue contains iron and steel, copper, aluminum, and some zinc, gold, and silver, as well as large quantities of glass. The metals obtained from urban ore are of high quality, since they have already been manufactured once and only need to be separated from the mass of ash.

The idea of "mining" the residue from city incinerators has been studied at College Park, Maryland, by a branch of the U.S. Bureau of Mines.

Just recently an EPA grant was given to the Massachusetts of Lowell to build a full-scale recycling plant using the technology developed by Bureau of Mines researchers. The facility, which will handle 250 tons of residue per day, is being built by the Raytheon Company.

This plant will sift glass and metal from the burned-out residue of municipal incinerators. The glass and metal will be sold, hopefully for a profit; the remaining incinerator ash will be less bulky than the original residue, and much simpler to dispose of.

The Lowell demonstration should prove the usefulness of mining the materials in incinerator residue. This kind of resource recovery plant holds great promise for cities that depend on incineration to process their waste.

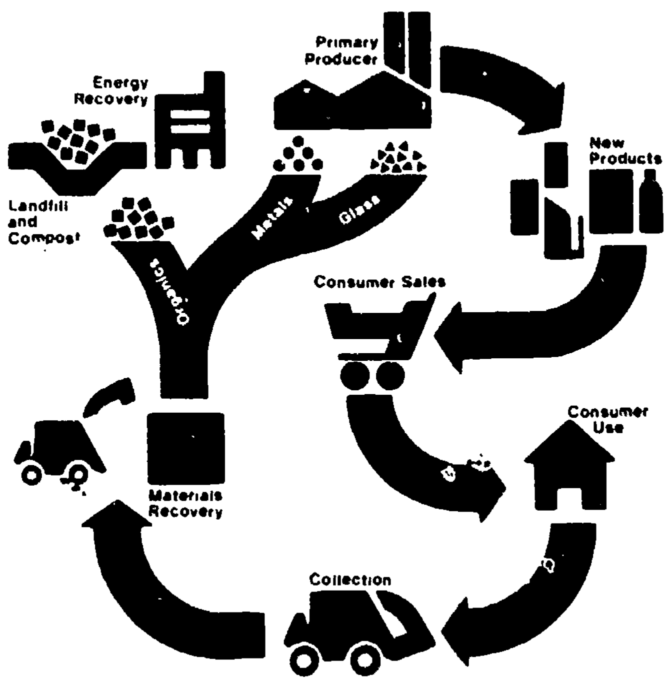
Hundreds of communities, of course, have no incinerator facilities, but rely on open dumps or landfills to dispose of their garbage. It is for towns and cities such as these that Bureau of Mines scientists are developing a system of recycling raw garbage. This sophisticated new system is undergoing tests at a pilot plant in Edmonston, Maryland.

There raw refuse goes through four major processes, some of them similar to the Franklin and Lowell systems.

First, a conveyor belt moves the refuse into shredders for grinding. Next, a magnetic separator removes pieces of iron and steel and an air classifier segregates heavy nonferrous objects from the light organic substances. The material is once again shredded to make paper and glass residue even smaller. Finally, a second air classifier blows lightweight food wastes, paper, and plastic material into a baling machine. All recovered materials are recycled for reprocessing and reuse.

In addition to the system already described, more than 20 cities are using some form of magnetic separation to sort ferrous and nonferrous metals for recycling and reuse. In California, the cities of Oakland and Sacramento reclaim steel cans at their landfill sites. The systems used in Atlanta, Georgia, and Tampa, Florida, do the separating after incineration. The one in Madison, Wisconsin, first shreds and then separates.

The systems just described handle inorganic waste—metals and glass. But what about all the organic components of city waste, like food and paper? These organic materials actually make up most of the refuse mix. Can we extract some value from them? Here, again, technology is at work, and the answer is "Yes."



Energy Recovery. Part of the answer to America's power shortage may be found in the most unlikely place—the city dump.

The theory, which is rapidly becoming reality, is based on the fact that garbage and trash of many kinds—but especially the organic fraction—will burn. And with today's fuel scarcity, there is increased interest in converting refuse into energy.

A number of systems now in development are designed to make maximum use of the lighter organic portion of urban refuse. As scientists find ways to convert organic refuse into new energy-yielding resources, yesterday's city dump may become tomorrow's "power works." In a total resource recovery operation everything going in, whether organic or inorganic, would become a usable product, such as fuel, fertilizer, steam, electricity, or salable materials.

Both in this country and abroad, modern pollution-controlled incinerators are using garbage and trash to produce steam. When burned, mixed municipal refuse heats about half as well as high-grade coal. The steam is then used either directly to provide central building heat or indirectly to drive gas turbines that produce electricity. In Paris, for example, much of the city's winter steam heat is produced by burning the city's own refuse. In our own country the Norfolk Naval Station in Virginia has been using garbage to generate steam since 1967. Chicago's Northwest incinerator, designed to produce heat as a by-product, will separate bi-metal cans from the refuse it receives.

Nashville, Tennessee, is another city using garbage as fuel. Nashville is spending over $16 million on a new plant which will be the first facility in the world to heat and cool a downtown area using refuse as a source of energy.

In the Nashville thermal transfer plant, large commercial boilers—like those used by the nation's utility companies—will burn fuel to produce steam energy. The steam is produced from water circulating through the walls of the boiler. These same water walls keep temperatures down inside the boiler. (Incinerator boilers such as these, differ from simple incinerators used for burning garbage.)

The first city to use garbage as a fuel in quantity, however, is St. Louis, Missouri. A full-scale demonstration program now operating here shows how to do this, and at the same time dispose of much of the city's waste.

This facility, jointly sponsored by the city, the Union Electric Power Company, and the U.S. Environmental Protection Agency, burns up to 300 tons of shredded refuse each day as a supplementary fuel in one of the electric company's coal-burning boilers. This burned waste produces enough electric power to serve 25,000 homes.

New York City also took a giant step in this direction when it announced the award of funds for a study to modify a boiler in a Consolidated Edison Company plant so it could burn 500-to-1200 tons of shredded garbage a day.

Another effective system is the one developed by the Combustion Power Company's research program in Menlo Park, California. This system is designed to use urban solid waste as a fuel to produce electricity. The pilot system, called the CPU-400, extracts metals and glass and burns the organic refuse under high pressure in a specially designed incinerator to produce electric power.

Besides burning the organic part of refuse as a substitute for other fuel, we can also convert garbage and trash into storable fuels. The pyrolysis form of incineration may bring us even closer to what may be called a state of "zero waste growth".

Instead of being burned, wastes placed in a closed chamber are baked at high temperatures in the absence of oxygen, reducing the volume by about 90 percent.

Pyrolysis plants are to be built in Baltimore, Maryland and San Diego, California.

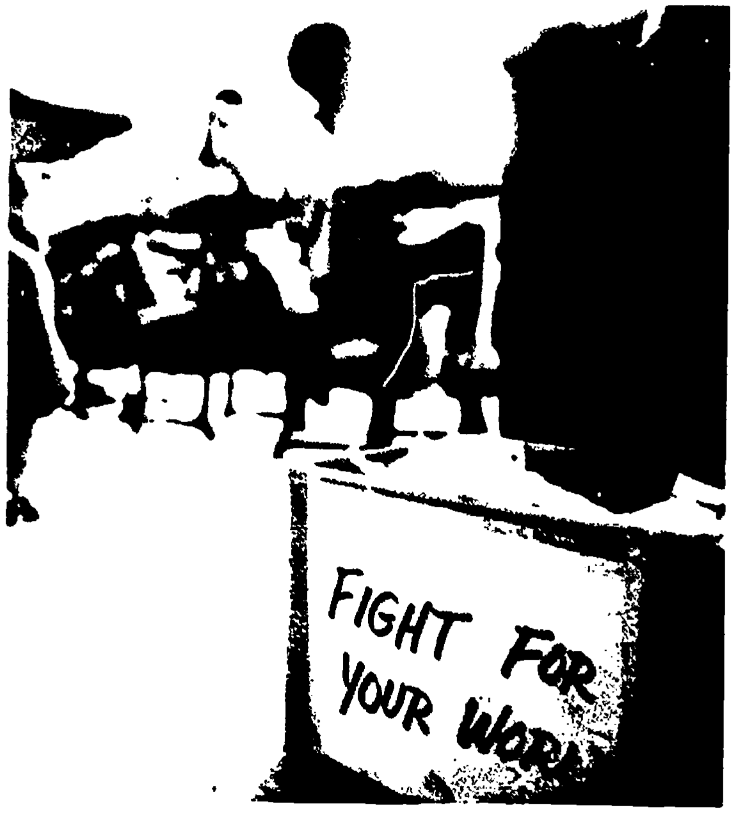
With the demand for electric power doubling each decade, all these ways to obtain heat and power from organic refuse are important additions to our energy resources. We may well be able to get back from garbage almost all the energy that it took away from the environment in the first place. This is resource recovery in its truest sense.

In addition to being a source of heat and power, organic refuse has other uses. One of these—composting—uses bacterial and chemical processes to convert organic wastes into soil conditioners that can enrich gardens and farmlands. As one of the oldest and most familiar forms of resource recovery, composting has until recently been used mainly by home gardeners.

At present municipal composting is most common in Europe, where few land sites for waste disposal remain. It was hoped that a profitable business of producing compost could be made in the United States. But composting has never become well established in this country because there are many other sources of less expensive chemical fertilizers. The costs of separating organic compounds from the waste stream and then of transporting the compost to the point of use are high. We must, however, also consider the benefits of composting in terms of health, cleanliness, and resource conservation, as well as the cost of alternative methods of disposal, before we dismiss it as uneconomical.

To sum up, the problem in resource recovery is not to invent new methods; the machines and processes needed already exist. What is needed is to make the best use of those already at hand in a resource recovery system. The valuable inorganic resources in our garbage and trash can be mechanically separated from mixed municipal refuse for recycling and reuse. The organic component left after this separation can be converted into energy or used to restore land.

V. SOLID WASTE MANAGEMENT SYSTEMS



EPA – DOCUMERICA – – James Olive

We know that value exists in the municipal trash heap, but this value is still largely untapped. To have value, materials must be recovered from refuse on a large scale. Before this can happen, however, answers must be found to the complex questions of cost, markets, and public attitudes in order to develop a lasting solution. It is a hopeful sign that in the United States today there is a growing public concern about the problem of solid waste and a sincere desire to face the challenge.

The challenge ahead. The solutions to our solid waste problems must come from the technology and the money that created these problems in the first place. But before we can begin, we must define the problems, look at the priorities and alternatives, and see what resources are needed to get the job done.

Just as in the total environment everything is somehow connected to something else, so are all the steps of handling our discards closely related. When we talk about a "systems approach" to solid waste management, we refer to each stage of the total process—from the time we throw things away through collection, removal, and final disposal. Along the way, these discards might be shredded, compacted, sorted, and processed for reuse.

The goal of effective solid waste management is to efficiently handle this waste. City managers and taxpayers want it all done as inexpensively as possible; responsible citizens demand that it be done with the least environmental harm;

conservationists stress that less of the total refuse be wasted, recognizing that waste is really a resource.

Who is involved in achieving these goals?

Until recently, the decision-makers were primarily those city officials, public works professionals, and the companies or city employees directly involved with the day-to-day planning and operation of solid waste collection and disposal. Now, it seems *everyone* has an interest. And that's the way it should be; for how we handle our trash and garbage affects us all — with either positive or negative results.

Any student, environmentalist or professional who takes time to study all the sides of the waste management issue must be aware there are no simple answers or solutions. Some of our cities have efficient collection systems, but still dispose of their garbage in an unsatisfactory manner. A few communities have both effective collection and disposal operations, but are running out of landfill space. Many municipalities desperately want to solve the trash problem, but do not have long-range waste management planning or adequate funds for better service. And, too many of our citizens have unrealistic attitudes.

For example, there are those who say, "We must do all we can to better handle and dispose of waste." Yet these same people take an altogether different view the moment they learn that a sanitary landfill might be built in their neighborhood. But if properly designed and managed landfills are indeed the only acceptable means of final disposal of solid waste, then more will be needed. Landfills will have to be located close to where the garbage is generated; enlightened citizens will have to accept this fact and realize that, when carefully planned and operated, sanitary landfills can add a plus to their community—even in the form of parks and playgrounds.

Another citizen group claims that modern management, technology, along with adequately funded plans, can solve all city ills. In dealing with solid waste, they are almost right. Certainly, until just a few years ago, these resources were either not available or not applied to most of our urban centers. But another key ingredient is in the so-called "institutional" area. This includes such things as modern laws and regulations to encourage efficient waste planning, management, and funding. Major progress has been made in waste management in the past five to ten years. New refuse handling systems and equipment show great promise, particularly the new, versatile compactor trucks; computerized routing of collection vehicles and crews; stationary compactors; transfer stations, and many of the improved methods of incineration and landfilling. On the horizon are exciting systems able to process mixed waste, recover metals and minerals, and produce energy. Across the country, city programs are springing up to collect old newspapers and other waste paper that has been bundled in the household or by business operations.

All of a sudden, it seems, solid waste is being viewed not as just the necessary by-product of our living, but as a mixture of resources to be sorted and put to valuable new use.

There are many vital partners in this new era of "waste consciousness". The federal government became fully involved with the passage of the Solid Waste Disposal Act of 1965, the first such law to assist states and municipalities in upgrading methods and practices. With enactment of the Resource Recovery Act of 1970, the federal effort expanded to encourage development of systems to recover "wealth" from waste. The Office of Solid Waste Management Programs (OSWMP) of the U.S. Environmental Protection Agency has the primary responsibility for technical and training assistance, and for funding a series of pilot projects to extract the energy potential from refuse, as well as to study and stimulate more efficient collection and disposal techniques.

State governments are also assuming a wider role in waste management and resource recovery. For example, Connecticut, New York, Wisconsin, and Maryland have established state plans and authorities to set standards and assist localities with waste problems; some of these states intend to build resource recovery operations on a large scale.

Municipalities and counties—which traditionally have had the responsibility of taking care of the waste generated in their jurisdictions—are now conducting long-range studies of this once-neglected, low priority area. As spearheaded by EPA's Mission 5000, more than 2000 open dumps have been closed since 1971; more efficient systems are being adopted; city clean-up and anti-litter programs conducted; etc. But much remains to be accomplished.

Business and industry, through a great variety of companies, are becoming more involved, including those that collect and dispose of our trash and garbage; those that build and operate systems and equipment; those that buy and use scrap, secondary materials and the products from voluntary collection programs and resource recovery facilities; those that manage plants and businesses that deal in any way with waste.

Altogether, the broad cross section of corporations, businesses, and the workers they represent, provides a key to waste management and resource recovery success; because the private sector is profit motivated, it must deliver a responsive and economical service. Since government at every level would never provide *all* the funding needed to manage our total waste and recovery resources, the private sector must be a strong partner.

Students, citizen organizations, and environmentalists—in fact, all of us—are the "new" constituency to be involved in the solid waste challenge. By learning how our community collects and disposes of its trash and garbage and investigating the pressures and priorities that must be considered, we can serve as "enlightened citizens" in helping to plan a better community.

But national action on the problem of solid waste requires more than the action of one community, one company, the government alone, or industry and labor by themselves. Somehow the knowledge and concern of all these groups must be joined in a common effort. One important step in this direction has already been taken. In 1970 a dozen industries making basic materials, packaging products, and consumer products joined together with American labor to form a unique nonprofit research organization, the National Center for Solid Waste Disposal. The organization is located in Washington, D. C. In 1971 the organization changed its name to the National Center for Resource Recovery (NCRR) in recognition of the importance of recovering valuable resources from mixed municipal waste.

The NCRR has developed four separate programs in relation to resource recovery. The first program provides for research into new and promising systems, including economic aspects of the system under study. The second program is for the analysis of present and developing technologies. The third program is concerned with demonstrations of total resource recovery systems. The fourth program seeks to develop public awareness of NCRR programs and to keep people informed of news in the field of solid waste management. Through these programs the NCRR unites the forces of American industry and labor in meeting the challenge of solid waste.

Resource Recovery Demonstration Program. One of the major efforts by NCRR to promote resource recovery will be a model resource recovery plant to be built in New Orleans in 1974. This carefully planned and engineered demonstration program is designed as the important missing link between the theory of resource recovery and the actual fact of an industry using modern technology to extract valuable materials from the municipal solid waste stream. The New Orleans system will process about 650 tons of refuse daily—the waste created by about 200,000 people. Part of the money needed to operate this New Orleans demonstration center will come from the city. The city will pay to the center disposal fees which are less than the present cost of disposal. More money will come from the sale of recovered materials.

In operation, City collection trucks will deliver refuse to the receiving area of the facility. After the removal by hand of bundled paper, trash and garbage will be shredded into small pieces. An air classifier will then separate the light and heavy elements; ferrous metals will be magnetically separated; small particles of mixed glass will be screened out; flotation tanks will be used to separate the larger pieces of glass and aluminum from the other non-ferrous metals (stainless steel, brass, copper, etc.); and, finally, the remaining glass will be optically sorted into clear and colored glass. The remaining shredded light organic material will be used as sanitary landfill.

During the pilot stage the demonstration program will test new technical discoveries and apply these to obtain additional recovery from light waste. New ideas will also be tried in energy recovery.

Conclusion. In the past, the U.S. was not much concerned about how it disposed of its solid waste. We did not care what we threw away or where we threw it. Today, the situation is very different.

We are living in a decade of fast change. A raw materials shortage and dwindling domestic supply have driven the price of secondary materials and energy upward. These shortages have been projected for many years to come. We have entered an era of environmental awareness and a newly recognized age of scarce national resources. Both of these factors have created a new mood, a new thrust, from an age of disposal to an age of recovery.

What we need is a broad public understanding of the problem involved and the ways they can be solved; we also need the foresight to choose wise solutions and the will to implement them. If we can learn to think of our trash not as junk but as the world's richest mine, we will have taken a long step toward wise management of the life-supporting systems of our Spaceship Earth.

RESOURCE RECOVERY SYSTEMS MAY EASE MATERIALS, ENERGY SHORTAGES

Resource recovery—reclaiming value from trash and garbage—is gaining wider acceptance across the country as a possible solution to the nation's diminishing natural resources and solid waste disposal problems. Now with the search for new energy sources increasing, several experts foresee household garbage as a potential source of power. There have been recent demonstrations that organic materials—including paper, plastics, rubber, and foodwaste—may be a partial answer to the energy crisis through their application as fuel and as a source of fuel.

Citizen involvement is well indicated by voluntary programs in some 350 cities where hand-separated bottles, cans, and papers are brought to collection centers for later recycling. But more meaningful programs for recovery are major plants springing up to process the total mass of daily discards.

According to the non-profit National Center for Resource Recovery (NCRR), several U.S. cities are either planning to or are now mechanically reclaiming resources from mixed solid waste.

A few of these cities are.

Franklin, Ohio: This is one of the most complete waste separation plants in the United States. Every day, 50 tons of raw, unsorted refuse is picked up and hauled to a new $2 million recycling plant. The waste is ground in water mixing tanks, then separated by special machinery into glass, metals, and paper fibers for recovery.

Hempstead, New York: The Black Clawson Company, which designed the Franklin system, has proposed a major resource recovery plant for this suburban Long Island community, the second largest population center in New York. The process would recover metals and glass. The remaining organic material would then be used as fuel to generate about 1,000,000 kilowatts of new electrical power per day—enough saleable electricity to supply about 20 percent of the households of Hempstead.

New Castle County, Delaware: A 1200-ton-per-day plant now in operation shreds the refuse. A magnetic system to extract ferrous metals—an estimated 250 million steel cans a year—is now being installed.

Lowell, Massachusetts: A plant scheduled for operation in late 1974 will process 250 tons of incinerator residue per day—equal to 2200 tons of raw refuse. Ferrous and non-ferrous metals and glass will be recovered.

New Orleans, Louisiana: The city, with the National Center for Resource Recovery as its technical adviser, plans a complete materials recovery system which will handle about 700 tons of refuse a day. It will reclaim ferrous and non-ferrous metals, glass, some of the newspaper and corrugated paperboard; remaining shredded light organic material will be used as sanitary landfill.

Norfolk, Virginia (U.S. Naval Base): The incinerator on this military base has been using heat from burning refuse to produce steam since 1967.

Chicago, Illinois: A city incinerator in northwest Chicago, basically a European type model, produces saleable steam as a by-product.

Chicago, Illinois: A plant scheduled for completion in 1975 will shred refuse for burning as fuel in an electric power plant and magnetically extract ferrous metals.

Nashville, Tennessee: This city began construction of a facility in 1972 which, using garbage as a fuel, will heat and cool a downtown area. Already, 32 buildings have contracted for heating and cooling from the thermal transfer plant. The facility is planned for completion in the summer of 1974 to process some 720 tons of garbage a day.

St. Louis, Missouri: Shredded municipal solid waste is being used as a supplementary fuel in a coal-burning electric power plant. In a federal-city-private industry program, an air classifier (which uses streams of air to separate organic and inorganic wastes) makes the burning operation more efficient.

Flushing, New York: A 600-ton-per-day plant is being designed to recover corrugated paperboard, paper fiber, ferrous metals, aluminum, and glass, and produce steam. Some of the steps are being operated on a pilot scale.

San Diego County, California: A plant now in final design will recover ferrous metals and glass from 200 tons of refuse per day, then convert most of the remainder into fuel by the process of pyrolysis—heating the refuse in an oxygen-free atmosphere.

Baltimore, Maryland: Another type of pyrolysis system, designed to process 1000 tons per day, should be in operation in mid-1974. Ferrous metals and a glassy aggregate for road construction will be recovered and the remainder heated in oxygen-deficient atmosphere. The gas which is produced will be used to generate steam.

Charleston, West Virginia: This solid waste pyrolysis system will begin operating early in 1974 at a 200-ton-per-day plant to produce a clean burning fuel gas. The process requires no initial shredding or separation of the refuse before entering the pyrolysis unit. The resultant gas, although lower in heating value than natural gas, has flame temperatures and heat-transfer characteristics similar to natural gas.

National Organizations

BEST COPY AVAILABLE

INDUSTRY AND LABOR

AFL-CIO
815 16th Street, N.W.
Washington, D.C. 20006
(National and Local Unions)

ALUMINUM ASSOCIATION
750 3rd Avenue
New York, N.Y. 10017
(Producers of Aluminum and Manufacturers of Semi-Fabricated Aluminum Products)

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION
25711 Southfield Road
Southfield, Mich. 48075
(Industrial Hygienists)

AMERICAN IRON AND STEEL INSTITUTE
150 East 42nd Street
New York, N.Y. 10017
(Basic Manufacturers in the Steel Industry)

AMERICAN NEWSPAPER PUBLISHERS ASSOCIATION
P. O. Box 17407
Dulles International Airport
Washington, D.C. 20041
(Publishers of Daily Papers in the U.S., Canada, Bahamas, Bermuda, Puerto Rico and U.S. Virgin Islands)

AMERICAN PAPER INSTITUTE
260 Madison Avenue
New York, N.Y. 10016
(Manufacturers of Pulp, Paper and Paperboard)

CAN MANUFACTURERS INSTITUTE, INC.
821 15th Street, N.W.
Washington, D.C. 20005
(Manufacturers of Metal Cans, Containers and Packages made wholly or in part from Tin Plate or similar Sheet Metal)

DISTILLED SPIRITS COUNCIL OF THE U.S., INC.
1132 Pennsylvania Building
Washington, D.C. 20004
(Domestic Distillers of Beverage Alcohol for Whiskey, Vodka, Gin and Rum)

FIBRE BOX ASSOCIATION
224 South Michigan Avenue
Chicago, Ill. 60604
(Manufacturers of Corrugated and Solid Fibre Shipping Containers)

GLASS BOTTLE BLOWERS ASSOCIATION
226 South 16th Street
Philadelphia, Pa. 19102
(Glass Bottle Blowers Union)

GLASS CONTAINER MANUFACTURERS INSTITUTE
1800 K Street, N.W.
Washington, D. C. 20036
(Glass Container and Closure Manufacturers, and Suppliers of Raw Materials and Equipment)

GROCERY MANUFACTURERS OF AMERICA
1333 Avenue of the Americas
New York, N.Y. 10036
(Manufacturers of Branded Food and Non-Food Products Sold Through Grocery Trade)

INCINERATOR INSTITUTE OF AMERICA
60 East 42nd Street
New York, N.Y. 10017
(Manufacturers of Incinerators for Municipal, Industrial, Commercial and Domestic Use)

INSTITUTE OF SCRAP IRON & STEEL
1729 H Street, N.W.
Washington, D.C. 20006
(Scrap Iron and Steel Processors and Brokers)

MANUFACTURING CHEMISTS' ASSOCIATION
1825 Connecticut Avenue, N.W.
Washington, D.C. 20009
(Manufacturers of Chemicals Who Sell a Substantial Portion of their Production to Others)

MOTOR VEHICLE MANUFACTURERS ASSOCIATION OF THE U.S., INC.
320 New Center Building
Detroit, Mich. 48202

NATIONAL ASSOCIATION OF FOOD CHAINS
1725 Eye Street, N.W.
Washington, D.C. 20006
(Retail Grocery Chains Operating 23,000 Individual Stores)

NATIONAL ASSOCIATION OF MANUFACTURERS
277 Park Avenue
New York, N.Y. 10017
(Representatives of American Manufacturing)

NATIONAL ASSOCIATION OF RECYCLING INDUSTRIES
330 Madison Avenue
New York, N.Y. 10017
(Dealers, Processors and Generators of Waste Materials for Recycling)

NATIONAL ASSOCIATION OF RETAIL GROCERS OF THE U.S.
360 North Michigan Avenue
Chicago, Ill. 60601
(Individual Food Retailers, Manufacturers and Distributors of Equipment, Food, Fixtures, Groceries and other Commodities used or sold by Food Stores)

NATIONAL CANNERS ASSOCIATION
1133 20th Street, N.W.
Washington, D.C. 20036
(Commercial Packers of Food Products in Hermetically Sealed Containers, Sterilized by Heat)

NATIONAL SOFT DRINK ASSOCIATION
1101 16th Street, N.W.
Washington, D.C. 20036
(Manufacturers of Soft Drinks)

NATIONAL SOLID WASTE MANAGEMENT ASSOCIATION
1145 19th Street, N.W.
Washington, D.C. 20036
(Commercial Solid Waste Collectors and Disposers)

PACKAGING INSTITUTE
342 Madison Avenue
New York, N.Y. 10017
(Users and Manufacturers of Packaging Materials, Machinery and Services)

PAPERBOARD PACKAGING COUNCIL
1250 Connecticut Avenue, N.W.
Washington, D.C. 20036
(Manufacturers of Paperboard Packaging)

SINGLE SERVICE INSTITUTE
250 Park Avenue
New York, N.Y 10017
(Manufacturers of Single-Service Food and Beverage Containers)

SOCIETY OF THE PLASTICS INDUSTRY
250 Park Avenue
New York, N.Y. 10017
(Manufacturers and Processors of Molded, Extruded Fabricated, Laminated, Calendered Plastic and Manufacturers of Raw Materials, Machinery, Tools, Dies and Molds)

SUPER MARKET INSTITUTE
200 East Ontario Street
Chicago, Ill. 60611
(Food Retailers and Grocery Wholesalers with Annual Sales Volume Above Certain Minimum)

UNITED STATES CHAMBER OF COMMERCE
1615 H Street, N.W.
Washington, D.C. 20006
(Voluntary Organizations of Business and Professional Men)

UNITED STEELWORKERS OF AMERICA
1500 Commonwealth Building
Pittsburgh, Pa. 15222
(Steel Industry Workers)

U.S. BREWERS ASSOCIATION
1750 K Street, N.W.
Washington, D.C. 20036
(Brewers of Beer and Allied Industry Companies)

GOVERNMENT AND PUBLIC

AMERICAN PUBLIC HEALTH ASSOCIATION
1740 Broadway
New York, N.Y.10019
(Community Health Workers)

CONFERENCE OF STATE SANITARY ENGINEERS
Division of Engineering
Michigan Department of Public Health
3500 North Logan
Lansing, Mich. 48914
(Sanitary Engineering Officials)

COUNCIL OF STATE GOVERNMENTS
Ironworks Pike
Lexington, Ky. 40505
(State Commissions on Interstate Cooperation)

INSTITUTE FOR SOLID WASTES
American Public Works Association
1313 East 60th Street
Chicago, Ill. 60637
(Consultants, Educators and Local Solid Waste Officials)

IZAAK WALTON LEAGUE OF AMERICA
1326 Waukegan Road
Glenview, Ill. 60025
(Conservationists)

KEEP AMERICA BEAUTIFUL, INC.
99 Park Avenue
New York, N. Y. 10016
(Industries, Conservation Groups, and Other Interested Parties)

LEAGUE OF WOMEN VOTERS
1730 M Street N.W.
Washington, D.C. 20036
(Women Citizens of Voting Age)

NATIONAL ACADEMY OF SCIENCES/ NATIONAL ACADEMY OF ENGINEERING
2101 Constitution Avenue, N.W.
Washington, D.C. 20418
(Quasi-Official Agencies Established by the Congress, Dedicated to the Furtherance of Science and Engineering)

NATIONAL ASSOCIATION OF COUNTIES
1001 Connecticut Avenue, N.W.
Washington, D.C. 20036
(County Officials)

NATIONAL AUDUBON SOCIETY
1130 5th Avenue
New York, N.Y. 10028
(Conservationists)

NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION
1600 Pennsylvania Avenue
Denver, Colo. 90203
(Environmental Health Professionals)

NATIONAL LEAGUE OF CITIES/ U.S. CONFERENCE OF MAYORS
1612 K Street, N.W.
Washington, D.C. 20006
(Cities and Mayors)

NATIONAL WILDLIFE FEDERATION
1412 16th Street, N.W.
Washington, D.C. 20036
(Conservationists)

NATURE CONSERVANCY
1522 K Street, N.W.
Washington, D.C. 20006
(Conservationists)

SIERRA CLUB
Mills Tower
San Francisco, Cal. 94104
(Conservationist and Outdoor Recreation Enthusiasts)

Glossary

ABANDONED MOTOR VEHICLE
An unwanted, inoperable motor vehicle that is declared abandoned according to state law

AEROBIC
Able to live and grow only if free oxygen is present

AEROSOL
Fine solid or liquid particles suspended in a gas

AGGREGATE
Crushed rock or gravel used in road surfaces and concrete

AGRICULTURAL WASTE
Waste materials left over from raising plants and animals for food These materials include such things as animal manure, plant stalks, hulls, and leaves.

AIR CLASSIFIER
A mechanical device that uses a force of air to separate

mixed trash and rubbish according to weight.

AIR DEFICIENCY
The condition in which there is not enough air in an air-fuel mixture to supply the quantity of oxygen needed to oxidize the fuel

AIR POLLUTANT
A substance discharged into the atmosphere in large enough concentrations to contaminate the environment

AIR POLLUTION
The condition in which the atmosphere has an overconcentration of harmful substances

AIR QUALITY STANDARDS
Legal restrictions on the quantity of a particular air-polluting substance that can be present in the air at any one time

ALUMINUM
A strong, light, silver-colored metal derived chiefly from bauxite. It is the most abundant metal in the earth's crust

AMBIENT AIR
The surrounding air

ANAEROBIC
Able to live and grow in the absence of real oxygen.

BACKEND LOADER
A refuse truck that loads refuse and trash from the rear of the truck and compacts it

"BACK-END" SYSTEM
Any of several processes for recovering value, such as energy, from the organic portion of the waste stream. Examples of such processes are fluid bed incineration, pyrolysis, composting, combustion, and fiber reclaiming

BACTERIA
Single-celled, microscopic organisms that can cause disease but that are also important to man because of their chemical effect on such things as solid waste

BAGASSE
An agricultural waste material consisting of the dry pulp residue remaining from the processing of sugarcane after the juice has been extracted. The fibers are used as raw materials in the manufacture of pulp and paper

BALING
A volume-reducing system in which waste material is mechanically compressed and bound into large cubelike shapes

BIOCHEMICAL OXYGEN DEMAND (BOD)
A measure of the amount of oxygen used by microorganisms to break down organic waste materials in water

BIODEGRADABLE
Capable of having its physical and/or chemical structure broken down by microorganisms. Most organic waste, such as food remains and paper, is biodegradable.

BIOSPHERE
The part of the earth's crust, water, and atmosphere where living organisms can subsist

BOXBOARD
Paperboard used in the manufacture of cartons and rigid boxes. (See PAPERBOARD.)

BRITISH THERMAL UNIT (BTU)
The amount of heat needed to increase the temperature of one pound of water one degree Fahrenheit. In resource recovery systems, BTU would be applied to indicate the amount of heat energy available if a given amount of waste was burned

BROKE
Paper that has been discarded anywhere in the process of manufacture. It is usually returned to a repulping unit for reprocessing.

BEST COPY AVAILABLE

BULKY WASTE
Large discarded articles, such as appliances, furniture, auto parts, and trees.

CARBONACEOUS MATTER
Carbon compounds or pure carbons that are present in the fuel residue of the combustion process

CARBON DIOXIDE (CO_2)
A colorless, odorless, nonpoisonous gas that forms carbonic acid when dissolved in water. It is produced during the thermal degradation and microbial decomposition of solid wastes.

CARBON MONOXIDE (CO)
A colorless, poisonous gas that has a very faint metallic odor and taste. It is produced during the thermal degradation and microbial decomposition of solid wastes when the oxygen supply is limited

CELL
A section of solid waste that is compacted and covered over by natural soil or a cover material in a sanitary landfill.

CENTRAL GARBAGE GRINDER
A site where all the food waste in a particular area is brought to be pulverized.

CLASSIFICATION
The arrangement and sorting of waste materials into categories or classes. This usually means grading by organic or inorganic composition, size, weight, color, shape, etc., in specialized equipment.

COLLECTION
The act of picking up waste materials at residences, businesses, or industrial sites and hauling it to a facility for processing.

COLLECTION CENTER
A place where individuals can take particular waste materials, such as glass or cans, or a place where government or private agencies can take wastes that they have collected.

COLLECTION VEHICLES
Vehicles used to pick up trash and haul it to a collection center or transfer station. (See BACKEND LOADER, COMPACTOR TRUCK, FRONTEND LOADER, SIDE LOADER.)

COLOR SORTING OF GLASS
A technique for sorting by color the glass reclaimed from solid waste. The sorting might be optical (which compares light reflected from each piece with light reflected from a background standard) or magnetic (which sorts colored glass containing iron from clear glass with no iron).

COMBUSTIBLES
Burnable waste materials, usually such organic materials as paper, plastics, wood, and food wastes.

COMBUSTION
The chemical combining of oxygen with a substance, resulting in the production of heat and usually light

COMMERCIAL WASTE
Waste material generated by commercial establishments such as office buildings, stores, markets, theaters, hotels, and warehouses

COMPACTOR
A mechanical device that compresses solid waste into smaller volume. This kind of processing system can reduce volume by 50 percent to 80 percent.

COMPACTOR TRUCK
A truck with an enclosed body that can mechanically load, compress, and distribute waste materials within the truck body.

BEST COPY AVAILABLE

COMPOSTING
The process of using microorganisms to convert organic material into humus for soil conditioners and low-grade fertilizers

CONSTRUCTION WASTE
Waste material from construction sites

CONSUMER WASTE
Material used and discarded by someone who bought it, as opposed to material discarded before it leaves the manufacturing plant

CONVERSION
A resource recovery method that uses chemical or biological processes to change waste materials into useful forms Examples are incineration to produce heat, pyrolysis to produce gas, oil, and char, and composting to produce humus. (See RECYCLING, REUSE, and TRANSFORMATION)

CONVEYOR
A mechanical device used to move materials between operations or as part of a processing system. Conveyors are used in handling waste materials at collection centers, transfer stations, and resource recovery plants

COVER MATERIAL
Inorganic material, usually earth, used to cover compacted solid waste in a sanitary landfill

CRUSHER
A mechanical device used to break up waste material into smaller sizes by a pounding action using hammers, beaters, etc. (See HAMMER MILL)

CULLET
Scrap glass, usually broken up into small uniform pieces It is often reused in the manufacture of new glass

28

CYCLONE SEPARATOR
A mechanical separator that uses swirling air to sort materials according to weight. (See SEPARATION)

DECOMPOSITION
The breakdown of organic waste materials by microorganisms. Total decomposition leaves only carbon dioxide, water, and inorganic solids. Decomposition occurs naturally in the open, as in dumps and landfills, or it can be harnessed in waste treatment equipment to work under controlled conditions (See BIODEGRADABLE and COMPOSTING)

DEINKING
A process in which most of the ink, filler, and other extraneous material is removed from printed and/or unprinted reclaimed paper. The result is a pulp that can be used, along with varying percentages of virgin paper, in the manufacture of new paper, including high-quality printing, writing, and office paper, as well as tissue and toweling

DEMOLITION WASTE
Waste materials produced from the destruction of buildings, roads, sidewalks, etc (See CONSTRUCTION WASTE, RUBBLE, SOLID WASTE, and WASTE MATERIALS)

DEWATERING
The process of removing water from waste by filtration, centrifugation, pressing, open-air drying, and other methods Dewatering makes sewage sludge suitable for disposal by burning or by landfill The term is also used when removing water from pulp

DIGESTER
A mechanical device that softens or decomposes waste material, usually for further processing

DISPOSABLE STORAGE CONTAINERS
Plastic or paper sacks used for temporary storage of solid waste

DISPOSAL
The final dispostion of wastes, usually through burning or burying

DISTILLATION
A separation process used to remove water from waste material in some treatment or recovery systems The water is vaporized, removed from the unit, and condensed back into a liquid

DUMP
An open land site where waste materials are burned, left to decompose or rust, or simply deposited. In most localities, dumps are being phased out because of the problems they cause, such as water pollution, creation of unsanitary conditions, and general unsightliness Dumps are also breeding grounds for rodents and other disease carriers

ECOLOGY
A branch of science concerned with the interrelationship of animals, plants, and the environment. (See ENVIRONMENT)

ECOSYSTEM
An ecological community of organisms and their surroundings

EFFLUENT
Solid, liquid, or gas waste that enters the environment as a by-product of extractive or manufacturing processes

ELECTROSTATIC PRECIPITATOR
A device that collects unwanted particles from a solution by using an electric charge to attract them onto a collecting electrode. This process is sometimes used in incinerators, furnaces, and treatment plants to collect or separate dust particles

EMISSIONS (GASEOUS)
Waste gases released into the atmosphere as the product of combustion.

ENERGY RECOVERY
A type of resource recovery in which all or part of the waste materials going into a recovery facility are burned to produce heat that can be used to produce steam for heating or for the generation of electricity (See CONVERSION.)

ENVIRONMENT
The conditions, circumstances, and influences surrounding and affecting the development of an organism or a group of organisms

ENVIRONMENTAL PROTECTION AGENCY (EPA)
An agency of the federal government formed in 1970 to have the responsibility for ensuring that governmental, residential, commercial, and industrial waste disposal activities do not adversely affect the physical environment

ENVIRONMENTAL SYSTEM
The interaction of an organism or a group of organisms with its natural and man-made surroundings

FERROUS
Pertaining to metals that are predominantly composed of iron In the waste materials stream, these usually include steel or tin cans, automobiles, old refrigerators, stoves, etc

FILTER
A device through which a liquid or gas is passed in order to remove particles or dust

FLUID BED INCINERATOR
An incinerator in which the waste material is fluidized by an upward-controlled air flow A bed of solids acts like a fluid when an upward flow of air has just enough velocity to float some of the solids One such incinerator confines combustion within a bed of waste and sand supported on a perforated plate Air is blown upward through the plate.

churning the waste and sand into a turbulent mass like quicksand Volatile gases are collected above the bed

FLY ASH
Small solid particles of ash and soot produced when burning coal. oil. or waste materials After these particles are collected. they can be used for making building materials such as brick or deposited in a sanitary landfill

FOOD CHAIN
A series or chain of plants and animals that depend on each other for a food supply An example is algae—shrimp—fish—man.

FOSSIL FUELS
Fuels such as coal. oil. and natural gas that are the remains of ancient plant and animal life.

FRONTEND LOADER
A truck with mechanical arms at the front that lift a refuse container up and over the cab to the back of the truck. where the contents of the container are dumped and compressed

"FRONT-END" SYSTEM
Any of several processes that separate and recover valuable resources from inorganic solid waste. Examples are shredding. grinding. screening. flotation. and magnetic and air separation

FURNACE
The area in an incinerator where the preheating. drying. ignition. and most of the burning of refuse take place

GARBAGE
Waste materials. usually food wastes. that are likely to decompose or putrefy

GASIFICATION
The process of converting a solid or liquid fuel into a gaseous fuel

GENERATION
The act or process of producing solid waste.

GLASPHALT
A highway paving material in which recovered ground glass replaces gravel in asphalt

GLASS
A transparent inorganic material that is produced by melting almost pure silica sand with burnt lime or limestone. with soda ash added to give hardness and chemical durability. Crushed glass. or cullet. has traditionally been added to make the mixture of raw materials more workable

GRATE
A surface that supports waste material. usually in the primary combustion chamber of an incinerator The surface has openings to permit the passage of air through the burning waste and to permit the removal of ash and unburned residue

GRAVITY SEPARATION (FLOTATION, HEAVY MEDIA)
Separation of materials according to specific gravity by immersion in liquid In solid waste recovery this process enables separation of the various nonferrous metals from other heavy materials

GRINDER
A mechanical device that pulverizes waste material into powder or small particles by rubbing them between two hard surfaces

GRINDING
The mechanical pulverization of solid waste (See SHREDDER)

GROUNDWATER
Water that is present in the zone of saturation of a bed of rock. sand. or gravel The upper surface of the groundwater forms the water table

HABITAT
The natural environment of an animal or a plant

HAMMER MILL
A mechanical device composed of heavy rotating hammers that crush waste materials into smaller size pieces

HETEROGENEOUS WASTE
Waste that contains a mixture of materials. such as metals. glass. paper. plastics. and food

HOMOGENEOUS WASTE
Unmixed waste material composed of similar materials. such as various kinds of paper waste

HULK
The body part of a vehicle that remains after such valuable parts as motor. transmission. and axles have been removed.

HYDRAPULPER
A large mechanical device used in the paper industry to pulp waste paper and separate foreign matter.

HYDROCARBONS
Any compounds containing only hydrogen and carbon. Hydrocarbon air pollutants come mostly from incompletely burned fuel

INCINERATION
The controlled process by which solid. liquid. or gaseous combustible wastes are burned and changed into gases. with the residue produced containing little or no combustible material. (See COMBUSTION. FLUID BED INCINERATOR. FURNACE. GRATE. INCINERATOR. PYROLYSIS. SCRUBBER. and WATER- WALL FURNACE)

INCINERATOR
A plant designed to reduce waste volume by combustion. Incinerators consist of refuse-handling and storage facilities. furnaces. combustion chambers. subsidence chambers. residue-handling and removal facilities. and chimneys. Complete conventional incineration reduces waste volume by about 90 percent. whereas high-temperature incineration achieves as much as 98 percent reduction.

INDUSTRIAL WASTE
Waste material generated by industry. (See WASTE MATERIALS.)

INORGANIC REFUSE
Waste material coming from matter other than plants. animals. certain chemical compounds. or carbon. Examples are metals and glass. (See ORGANIC REFUSE.)

IN-PLANT WASTE
Waste material discarded during the manufacturing process. It can be and usually is recovered and recycled within the plant.

INSTITUTIONAL WASTE
Waste material coming from schools. hospitals. public buildings. etc.

JUNK
Waste materials—such as rags. paper. metal. toys. and furniture—that are usually suitable for recycling and reuse.

KRAFT PAPER
A comparatively coarse paper made primarily from wood pulp produced by the sulfate pulping process and particularly noted for its strength. Its unbleached grades are used mainly as a wrapping or packaging material.

LEACHATE
Liquid that drains out of landfills and that contains decomposed waste. bacteria. and other contaminants. It must be collected and treated so as not to contaminate water supplies

BEST COPY AVAILABLE

LITTER
Solid waste that has been carelessly discarded by the consumer and that is outside the system for collecting and disposing of trash and garbage

MAGNETIC SEPARATOR
A mechanical device that uses a magnet to sort ferrous material from general waste material (See SEPARATION.)

MANUAL SEPARATION
The separation of waste materials by hand

MATERIALS RECOVERY
One of the concepts of resource recovery in which the emphasis is on separating and processing waste materials to be sold for various purposes

MECHANICAL SEPARATOR
Any separator of waste materials that is mechanical in design. such as a cyclone or screen separator (See SCREENING and SEPARATION.)

METALS
All ferrous. nonferrous. and alloy materials

METHANE (CH_4)
An odorless. colorless, and asphyxiating gas produced by solid waste undergoing anaerobic decomposition Under certain circumstances this gas is highly explosive

MICROORGANISM
Any living thing of microscopic size. such as bacteria. yeasts. simple fungi. some algae. slime molds. and protozoans Microorganisms are involved in the composting of waste materials and in sewage treatment processes

MIXED PAPER
Wastepaper of various kinds and levels of quality. usually collected from stores. offices. and schools

MUNICIPAL SOLID WASTE
Waste materials produced in a municipal area containing both residences and businesses

NEWSPRINT
The kind of paper generally used for printing newspapers

NONFERROUS
Pertaining to metals that contain no iron In solid waste these are usually aluminum. copper wire. brass. and bronze

OCEAN DUMPING
The dumping of raw or treated wastes in the sea beyond the continental shelf Ocean disposal. if not completely eliminated. should be carefully controlled so as to limit the kind. amount. and areas over which the wastes are dumped Such control is needed to guarantee that the ecological balance of the sea is not disturbed

OFFAL
Intestines and discarded parts of slaughtered animals

OPEN BURNING
The burning of solid waste in the open. in outdoor incinerators. or in a dump Such burning is usually intentional but sometimes accidental

ORGANIC REFUSE
Waste material made up of substances composed of chemical compounds of carbon in combination with other chemical elements. primarily hydrogen. and generally manufactured in the life processes of plants and animals These materials include paper. wood. food waste. plastic. and yard wastes (See INORGANIC REFUSE.)

PAPER
The general name for all kinds of matter or felted sheets of fiber formed on a fine screen from a water suspension More specifically. paper is one of two broad subdivisions. the other being paperboard of the general term *paper* Paper. usually lighter in basis weight. thinner. and more flexible than paperboard. is used largely for printing. writing. wrapping. and sanitary purposes

PAPERBOARD
Fiber sheets that are relatively heavier in basis weight. thicker. and more rigid than paper There are three broad classes of paperboard container board. boxboard. and such special types as automobile board. building board. and tube board.

PAPERSTOCK
A general term used to designate wastepapers that have been sorted or segregated at the source into various recognized grades Paperstock is a principal ingredient in the manufacture of certain types of paperboard.

PARTICULATES
Suspended particles of ash. charred paper. dust. soot. and other partially burned matter carried in the residue of combustion

PLASTICS
Man-made materials containing primarily carbon and hydrogen. with lesser amounts of oxygen. nitrogen. and various organic and inorganic compounds. Plastics. which are technically referred to as "polymers." are normally solid in their finished state

PNEUMATIC COLLECTION (SOLID WASTE)
A mechanical system for conveying solid waste through transport pipes. When the system is in operation, a vacuum is developed and a high-velocity air stream is drawn through lateral pipes Refuse that is dropped into this moving air stream from standard gravity chutes is carried to a collection point

POLLUTION
The contamination of soil. water. or the atmosphere by the discharge of waste or offensive materials. such as gases or chemicals

POPULATION
All the people living in a certain area. also all the living things in a certain area.

PRECIPITATION
The physical or chemical separation of a solid substance from a solution. Separation. as in waste treatment processes. is usually induced

PRIMARY MATERIALS
Resources used for manufacturing basic products Examples include wood pulp for paper iron ore for steel. silica sand for glass. and bauxite for aluminum.

PRIVATE UTILITY
A firm providing service under a government license or contract to collect. transport. process. or dispose of solid waste

PULP
Fiber material that is produced by chemical or mechanical means. or a combination of the two. from fibrous cellulose raw material and from which. after suitable treatment. paper and paperboard are made. The raw materials may include virgin wood pulp. secondary fibers. or rags

PULPING SYSTEM
A system of equipment used to convert wood and other fibers into a slurrylike homogeneous mixture of water and fibers that can be further processed into paper products

PULPWOOD
Roundwood cut from trees and prepared primarily for manufacture into wood pulp or wood fiber. This term does not include chips and sawdust produced as residues of lumber and plywood operations. but it does include chips manufactured from roundwood in the forest or at chipmills remote from a pulp mill

PULVERIZATION
The crushing or grinding of material into small pieces (See GRINDING and SHREDDER.)

PUTRESCIBLE
Capable of being decomposed by microorganisms

PYROLYSIS
The process of chemically decomposing an organic substance by heating it in an oxygen-deficient atmosphere. High heat is usually applied to the material in a closed chamber, evaporating all moisture and breaking down materials into various hydrocarbon gases and carbonlike residue. The gases may be collected with suitable equipment and used or sold. The residue may be further processed into useful materials—such as carbon, sand, and grit—or it can be landfilled.

RAW MATERIALS
Unprocessed materials as they come directly from the land

RECLAMATION
The restoring of waste materials to usefulness. The reclaimed materials may be used for purposes that are different from their original usage.

RECOVERABLE RESOURCES
Any material that still has useful physical or chemical properties after serving a specific purpose and that can then be reused or recycled, either for the same purpose or for a different one.

RECOVERY
The process of obtaining usable materials or energy values from solid waste

RECYCLING
A resource recovery method involving the collection and processing of a waste product for use as a raw material in the manufacture of the same product or a similar one. An example is the use of ground glass in the manufacture of new glass. (See CONVERSION, REUSE, and TRANSFORMATION.)

REDUCTION TECHNIQUES
Methods to lessen the quantity of various materials in solid waste and to make them into a form suitable for reuse or disposal. (See BALING, COMPACTOR, CRUSHER, GRINDER, HAMMER MILL, and SHREDDER.)

REFUSE
A term commonly used for all solid waste materials (See WASTE MATERIALS.)

RENDERING
A waste material recovery process in which the remains of animals and fish and other wastes from slaughterhouses and butcher shops are cooked or treated with a solvent to derive fats, oils, and a protein residue. The fats and oils are used to make soap, and the residue is used as feed for animals

RESIDENTIAL WASTE
Waste materials discarded from houses and apartments

RESIDUE
Solid materials that remain after gases and liquids have been removed by chemical or physical processes, such as burning, evaporation, distillation, or filtration. (See INCINERATOR and SLUDGE.)

RESOURCE RECOVERY
The extraction and utilization of materials and values from mixed municipal waste. Materials recovered include metals and minerals that can be used in the manufacture of new products. Recovery of values includes energy recovery by utilizing components of waste as a fuel, production of compost using solid waste as a medium, and reclamation of land through sanitary landfills. (See CONVERSION, RECYCLING, REUSE, and TRANSFORMATION.)

RESOURCE RECOVERY ACT OF 1970
An act of Congress that directs the federal government to emphasize resource recovery as a means of handling solid waste; to accept responsibility for research training, demonstrations of new technology, technical assistance, and grants-in-aid for state solid-waste management agencies; and to create a National Commission on Materials Policy to recommend means for extraction, development, and use of materials susceptible of recycling, reuse, or self-destruction.

REUSE
The use of a waste material or product more than once. (See CONVERSION, RECYCLING, and TRANSFORMATION.)

RUBBER
An elastic substance produced by coagulating the milky juices of various tropical plants. After being laid out in sheets to dry, the rubber can be modified by chemical treatment to increase its useful properties

RUBBISH
A general term for solid waste that does not contain food waste.

RUBBLE
Waste materials made up mainly of broken pieces of brick, cinder blocks, cement, or rock but that may also contain pieces of lumber or other construction materials. (See WASTE MATERIALS.)

RUNOFF
The portion of precipitation—rain or snow—or irrigation water that drains from an area as surface flow.

SALVAGE
The extraction of materials from the waste stream for reuse.

SANITARY LANDFILL
A method of disposing of refuse on land without creating nuisances or hazards to public health or safety. This method requires careful preparation of the fill area and control of water draining from it. Heavy tractorlike equipment spreads the waste in thin layers, compacts it to the smallest practical volume, and then covers it with at least six inches of compacted dirt at the end of each day. After the area has been completely filled up in this manner, covered with a final two- to three-foot layer of dirt, and allowed to settle an appropriate time, the reclaimed land may be turned into a recreational area or, under carefully controlled conditions, have certain types of buildings constructed on it.

SCRAP
Waste material that is usually segregated and suitable for recovery or reclamation. (See WASTE MATERIALS.)

SCREENING
Separating pulverized waste material into various sizes by using a sievelike device. This is usually done in two or more stages, each stage having a different mesh size.

SCRUBBER
A device that removes unwanted dust particles from an air stream by spraying the air stream with a liquid, usually water, or by forcing the air through a series of baths (See ELECTROSTATIC PRECIPITATOR and MECHANICAL SEPARATOR.)

SECONDARY MATERIALS
All types of materials that have fulfilled their useful function and that usually cannot be used further in their present form or at their present location. Also included in this definition are materials that occur as waste from the manufacturing or conversion of products

SEEPAGE
Movement of water or gas through soil without the forming of

definite channels

SEPARATION
The manual or mechanical division of waste into groups This separation can be either general, such as all paper products from metals, or specific, such as clear glass from colored glass.

SEPARATION TECHNIQUES
Methods for separating out the various kinds of materials—such as paper, glass, and metals—found in solid waste (See AIR CLASSIFIER, CYCLONE SEPARATOR, FILTER, GRAVITY SEPARATION, HYDRAPULPER, MAGNETIC SEPARATOR, MANUAL SEPARATION, MECHANICAL SEPARATOR, PRECIPITATION, PULPING SYSTEM, and SCREENING)

SHREDDER
A mechanical device that breaks waste material into smaller pieces by using a tearing action

SIDE LOADER (REFUSE TRUCK)
A compactor truck in which solid waste is loaded into the side

SLUDGE
Semiliquid waste that is the residue from the treatment of sewage

SMOKE
Fine solid or liquid particles suspended in gas produced during the burning of carbonaceous material

SOIL
The loose natural surface material present above bedrock

SOLID WASTE
All useless, unused, unwanted, or discarded solid materials

SOLID WASTE MANAGEMENT
The management of the entire process of generation, storage, collection, transportation, processing, reclamation, and disposal of solid waste

STEEL
An alloy of iron that contains carbon in any amount up to about 1 7 percent as an essential alloying constituent Steel is malleable under suitable conditions

TRANSFORMATION
A resource recovery method involving the collection and treatment, by means other than biological or chemical, of a waste product for use as raw material in the manufacture of a different product An example would be the use of recovered and ground-up glass in making bricks (See CONVERSION, RECYCLING, and REUSE)

TRASH
Waste materials that usually do not include garbage but that may include other organic materials, such as plant trimmings (See WASTE MATERIALS)

URBAN WASTE
All the waste materials generated from an urban area (See WASTE MATERIALS)

VECTOR
A living insect or other arthropod or an animal (not including humans) that transmits infectious disease from one person or animal to another Open dumps provide a haven for vectors

VIBRATING SCREEN
A mechanical device that sorts material according to size Vibrating helps to prevent clogging and to move the material through the screen. Mechanical screens are used either wet or dry and in single or multiple decks

VIRGIN MATERIAL
Any basic material for industrial processes that has not previously been used (See PRIMARY MATERIALS and SECONDARY MATERIALS)

VOLUME REDUCTION
To process waste materials in such a way as to decrease the amount of space the materials occupy. (See COMPACTOR and INCINERATOR)

VOLUME REDUCTION PROCESSES
Reduction of solid waste is presently accomplished by four major processes: (1) mechanical, using compaction techniques (sanitary landfill, baling, etc); (2) thermal, using heat (incineration, pyrolysis), (3) biological, using bacterial action to decompose organic waste (composting, aeration, etc.), and (4) chemical, using chemical agents such as acids, oxides, chlorine, and solvents to oxidize, neutralize, and otherwise alter the character of waste material (See BIODEGRADABLE, COMPOSTING, INCINERATION, PYROLYSIS, and SANITARY LANDFILL)

VOLUNTARY RECYCLING (COLLECTION) CENTER
Generally, a volunteer-operated facility where the public can deposit separated waste materials, such as cans, bottles, and newspapers These materials are then collected and taken to recycling facilities

VOLUNTARY SEPARATION
The manual separation of glass bottles, food and beverage cans, or newspapers by individuals or groups of people, either at home or in local collection centers.

WASTE MATERIALS (SOLIDS)
A wide variety of solid materials that are discarded or rejected as being spent, useless, worthless, or in excess. This does not usually include waste solids found in sewage systems and water resources or those emitted from smokestacks.

WASTE PROCESSING
An operation such as shredding, compaction, composting, and incineration in which the physical or chemical properties of waste are changed to reduced size or volume to make handling easier

WASTE STREAM
A general term used to describe the total waste material generated by an area, a location, or a facility.

WATER TABLE
The level of the upper surface of groundwater Wells may be drilled to this depth in order to obtain water for drinking and irrigation (See GROUNDWATER.)

WATER-WALL FURNACE
A furnace with walls made of welded steel tubes through which water is circulated to absorb the heat of combustion These furnaces can be used as incinerators The steam or hot water generated may be put to a useful purpose or simply used to carry the heat away to the outside environment.

WINDROWING
The composting process of sorting and shredding refuse, placing it in long rows (usually five or six feet deep), and turning the piles for natural aeration In modified windrowing, a quicker and more efficient method, controlled amounts of air are blown through the material being composted

WOOD PULP
The basic primary material from which most papers are made It consists of small, loose wood fibers mixed with water

YARD WASTE
Grass clippings, prunings weeds, and other discarded materials from yards and gardens